

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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No. 4

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES
PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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Roentgen Observations of the Ileostomy in Patients with Idiopathic Ulcerative Colitis

II. Ileostomy Dysfunction¹

FELIX G. FLEISCHNER, M.D., and PAUL MANDELSTAM, M.D.

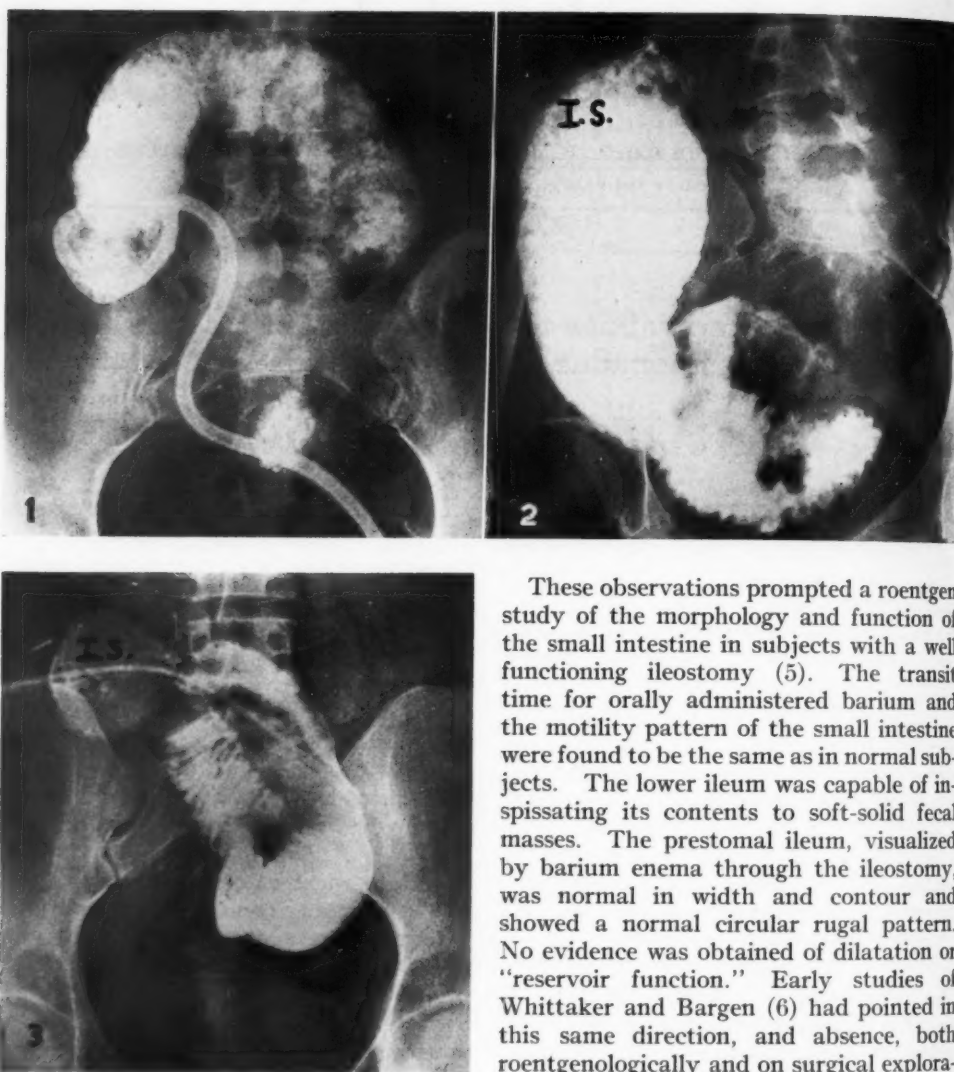
THERE HAS BEEN increasing recognition in recent years that an ileostomy, indispensable in the management of many patients with ulcerative colitis, often leads to a formidable array of serious difficulties, alluded to in Bargaen's assertion that "... success of the surgical therapy of chronic ulcerative colitis is still sharply limited by the problems associated with the ileac stoma" (1). Rogers, Bargaen, and Black, in a review of the clinical courses of 124 patients in whom ileostomy had been performed at the Mayo Clinic during the period 1940-49, found that patients who survived the operation one year with no serious complication represented but 14 per cent of the entire group (2). Warren and McKittrick, in a study of the Massachusetts General Hospital cases, have noted a similar incidence of ileostomy difficulties (3).

The complications of ileostomy are numerous, including major skin excoriations, wound dehiscence, fistulas, prolapse, retraction, and the syndrome of obstruction with prestomal ileitis and fluid and electrolyte imbalance, aptly termed by Warren and McKittrick "ileostomy dysfunction." This complication, sometimes life-threatening and even fatal, has been reported by Warren and McKittrick in 62

per cent of their patients. Rogers and his associates found intestinal obstruction of marked degree in 46 per cent of their patients and minor degrees of obstruction in many more. Similarly, Colcock and Mathiesen had a 46.3 per cent incidence of obstruction in their ileostomy series (4). Partial or complete obstruction may occur in the early postoperative period. This report, however, deals with the later chronic or relapsing ileostomy dysfunction.

Over the years, one of us (F. G. F.) has been called upon from time to time to undertake roentgen examinations in ileostomy patients to demonstrate the site and nature of an apparent obstruction, for which the stoma seemed too patulous to be responsible. Other patients were studied because of severe nutritional depletion or marked abnormalities in ileal discharge. In none of our cases could a cause of obstruction be found in the more proximal portions of the intestine, and the impression was gained that the malfunction was related to the cutaneous ileostomy ring and the dilatation encountered immediately proximal to it. The relative narrowness of the ring, together with diminution or absence of propulsive capacity of the terminal ileum, appeared to be responsible for the dysfunction.

¹From the Departments of Radiology and Medicine, Beth Israel Hospital and Harvard Medical School, Boston, Mass. Accepted for publication in September 1957.



Figs. 1-3. Case I.

Fig. 1. Ileostomy enema, April 10, 1950. The prestomal loop, visualized for a distance of 25 cm., is dilated to 4.5 cm. in diameter. It contains semisolid material. Circular folds are faintly visible only in the proximal portion.

Fig. 2. Ileostomy enema, Nov. 3, 1952. The terminal loop is markedly dilated for a distance of 30 cm., with a maximum diameter of 8.5 cm. There is a complete absence of circular folds in the terminal area.

Fig. 3. Ileostomy enema, May 27, 1953, four months after the performance of ileal resection. The terminal loop is slightly dilated and shows moderately flattened circular folds.

These observations prompted a roentgen study of the morphology and function of the small intestine in subjects with a well functioning ileostomy (5). The transit time for orally administered barium and the motility pattern of the small intestine were found to be the same as in normal subjects. The lower ileum was capable of inspissating its contents to soft-solid fecal masses. The prestomal ileum, visualized by barium enema through the ileostomy, was normal in width and contour and showed a normal circular rugal pattern. No evidence was obtained of dilatation or "reservoir function." Early studies of Whittaker and Barger (6) had pointed in this same direction, and absence, both roentgenologically and on surgical exploration, of enlargement of the prestomal ileum in cases of well functioning ileostomy was demonstrated by Dennis and Karlson (7). The subsequent observations of Madell and Golden (8) confirmed the findings of these latter workers and were in accord with our own experience.

In the light of our present knowledge of the behavior of the well functioning ileostomy, the roentgen findings of dysfunction can be better assessed. The histories of 5 patients with severe ileostomy dysfunction will be presented, with emphasis on the

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roentgen observations as related to the clinical course.

CASE REPORTS

CASE I: R. M., a 32-year-old housewife, had a skin-grafted ileostomy, established in March 1950 because of intractable ulcerative colitis. Post-operatively episodes of vomiting, crampy abdominal pain, and distention occurred, together with an almost continual profuse ileal discharge. A small-intestinal enema on April 10, 1950 (Fig. 1), showed narrowing at the stomal margin and considerable dilatation of the prestomal loop. No significant relief of symptoms followed excision of 2.5 cm. of prolapsed ileum and removal of part of the skin surrounding the ileostomy base in September 1950.

Over the ensuing two and one-half years the ileal discharge was almost always excessive. The patient was malnourished and was incapacitated by recurrent episodes of nausea, vomiting, and abdominal pain, with or without distention. These difficulties often resulted in severe dehydration, metabolic alkalosis, and tetany, and frequent hospital admissions were required for intravenous fluid administration and electrolyte replacement. Small intestinal enema studies during this period revealed marked dilatation of the prestomal loop without evidence of any organic obstruction proximal to the stomal ring (Fig. 2).

A psychogenic basis for the recurrent episodes of vomiting was strongly suspected. In view, however, of the ambiguous clinical picture and the roentgen evidence of cholelithiasis, cholecystectomy was performed in November 1952, but without clinical improvement. At operation, the terminal ileum appeared considerably dilated, but no organic obstruction was recognized. Low small-intestinal dilatation was again demonstrated on Jan. 7, 1953, on erect films and by ileostomy enema. In the following month, 34 cm. of ileum were resected and a new ileostomy was formed. The wall of the resected ileum was markedly edematous and inflamed and showed many shallow ulcers scattered over the mucosal surface. The pathologic diagnosis was severe nonspecific ileitis.

The patient recovered dramatically, with cessation of nausea, vomiting, and profuse ileal discharge. She rapidly regained her normal weight and was able to resume her household activities.

A small-intestinal enema ten weeks postoperatively revealed slight widening of the prestomal ileum (Fig. 3). During the four years which have since elapsed, the patient has continued to do well, leading a normal active life as a housewife and mother. Because of intermittent rectal bleeding, elective resection of the colon and rectum was performed.

Case II: D. L., a 30-year-old housewife, was operated upon in January 1951 for fulminating ulcera-

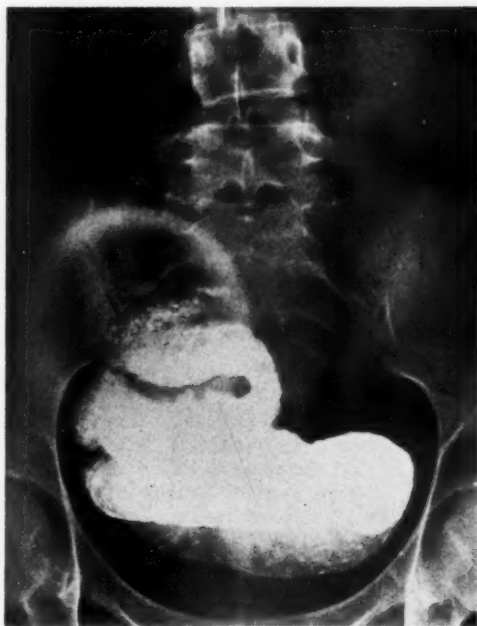


Fig. 4. Case II. Upper gastrointestinal examination, July 25, 1952, five hours p.c. The white ring in the right midfield is caused by the ileostomy bag plate. The prestomal ileal loop is maximally dilated for a recognizable length of about 25 cm. and contains barium and nonopaque liquid material. This loop narrows slightly toward the stoma. The examination demonstrated that there was no stenosis in any proximal portion of the bowel.

tive colitis. Two perforations of the colon and diffuse pericolicitis were found. The perforations were closed and, since the roentgen examination had shown involvement of a portion of the small bowel, 30 cm. of ileum were resected. An ileostomy was established, and the distal ileal loop, grossly normal, was exteriorized. Three months later a lumbar abscess appeared and was treated by incision and drainage. The patient's condition improved, with a gain of 22 lb. in weight. In June 1951, a subtotal colectomy was performed, including also the exteriorized terminal ileum. In the specimen no disease was found in the terminal ileal loop.

The patient did well for the following five months. In December 1951, however, the ileostomy discharge became profuse, 1,500 to 2,000 c.c. daily, and on introduction of a catheter through the stoma 300 to 500 c.c. of ileal content would often be evacuated in a gush. Frequent episodes of weakness, lethargy, muscle cramps, distention, and abdominal pain occurred, and dehydration, azotemia, and profound sodium and chloride depletion necessitated parenteral fluid administration every ten to fourteen days. Weight loss and malnutrition progressed. The cause of the patient's difficulties was

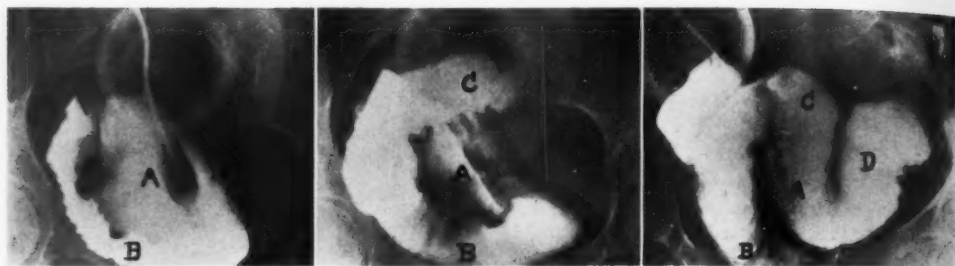


Fig. 5. Case II. Ileostomy enema, July 28, 1952. Three stages of filling (view to extreme right in slight rotation). The ileostomy bag is seen in the upper portion of the pictures. The inflated balloon of the Foley catheter causes the ovoid negative shadow. The visualized terminal 25 cm. are considerably dilated, up to 4 cm. diameter. The circular folds are partially thickened and flattened, partially absent. Identical portions of the prestomal ileum have been labeled by the letters A, B, C, and D, respectively.

far from clear. Addison's disease was considered by some to be a major contributing factor.

By July 1952 the patient's weight had decreased to 82 lb. A small fistula had developed at the edge of the stoma and discharged feces. Roentgen examinations of the small intestine on July 25, 26, and 28 (Figs. 4 and 5) revealed markedly dilated lower small intestinal loops containing gas and fluid. The transit of barium through the small intestine was greatly delayed. An ileostomy enema revealed a redundant prestomal loop with grossly irregular mucosal relief, containing a large amount of fluid. The dilatation extended down to the stoma, and no narrowing could be found in the higher loops. On July 30, 30 cm. of terminal ileum were excised and a new stoma was constructed. Pathological examination showed marked dilatation and thickening in the 25 cm. proximal to the excised stoma. The mucosa was inflamed and hypertrophied and exhibited numerous ulcerations from the size of a millet seed to that of a pea, with many small polypoid elevations from the ulcer bases. The ileostomy stoma was 2.4 cm. in diameter and admitted the tip of the little finger. About the internal opening of the fistulous tract was an ulcer with many pseudopolyps. The excised mesentery contained multiple hyperplastic lymph nodes.

The patient made a rapid recovery, regained the weight she had lost, and was soon able to lead a normal life. She became pregnant fourteen months postoperatively and uneventfully carried through to term. At present, five years after ileal resection and ileostomy reconstruction, she weighs 125 lb. and carries on the usual activities of a housewife and mother.

Case III: L. R., a 44-year-old woman, underwent an emergency ileostomy in 1948 for a fulminating, intractable ulcerative colitis and its complications. In January 1951, because of the development of obstructive symptoms, a stomal fistula, arthritis, and erythema nodosum, the ileostomy was revised and subtotal resection of the colon was carried out. Two months later, development of a fistula through

which most of the ileal contents drained led to a second ileostomy and resection of 30 cm. of ulcerated ileum.

The patient was incapacitated over the next two years. She was unable to gain weight; the ileostomy discharge was profuse, resulting in marked erythema and inflammation about the stoma; there was constant pain at the stoma and frequent episodes of acute abdominal pain and distention accentuated her difficulties. She deteriorated mentally to such a degree that schizophrenia was seriously suspected.

Upon admission to the hospital for study in April 1953, there was clinical and laboratory evidence of malnutrition, with obvious weight loss, hemoglobin of 8.4 gm./per cent, and plasma proteins of 5.4 gm./per cent. The ileal stoma freely admitted the index finger. A barium enema introduced through the ileostomy (Fig. 6) showed marked dilatation and edema of the prestomal ileum.

During a meticulous five-month regimen of regular digital dilatation of the stoma and catheterization of the terminal ileum, the patient continued to do poorly and her weight dropped further to 100 lb. Accordingly, she was explored on Sept. 30, 1953; a 5-cm. segment of ileum was resected, and the ileostomy was revised. In the specimen the stomal orifice was 1.5 cm. in diameter and readily admitted the tip of the index finger. An area of constriction was seen beneath the skin margin and just proximal to this narrowing two necrotic ulcers were found. The mucosa of the resected ileum was edematous, hemorrhagic, and polypoid.

Postoperatively the patient had no further difficulties. She rapidly regained weight and strength and made a satisfactory social and emotional adjustment. In July 1955, she uneventfully underwent elective abdominoperineal resection of the rectum. Her present weight is 126 lb. and she is leading an active, vigorous life both at home as a mother and housewife and in the community.

Case IV: S. B., a 38-year-old salesman, underwent ileostomy and subtotal colectomy in 1949 be-

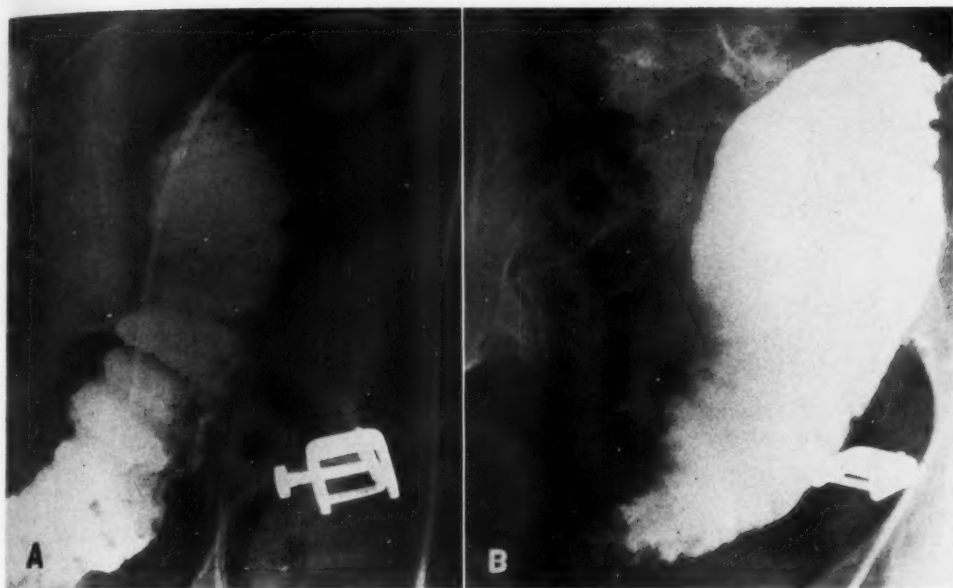


Fig. 6. Case III. Ileostomy enema. Two spot-films in rapid succession. In A, the dilated prestomal loop is seen in resting condition, with widely spaced, irregular circular folds. In B, a forceful contractile wave travels toward the ileostomy, squeezing the content ahead of it. The terminal loop is maximally dilated up to the stoma, to a diameter of 9 cm., with no barium passing the stoma: "stenosis peristalsis."

cause of long standing, intractable ulcerative colitis. The ileostomy was formed 10 cm. proximal to the ileocecal valve. The pathological examination revealed no abnormalities in the resected segment of the terminal ileum.

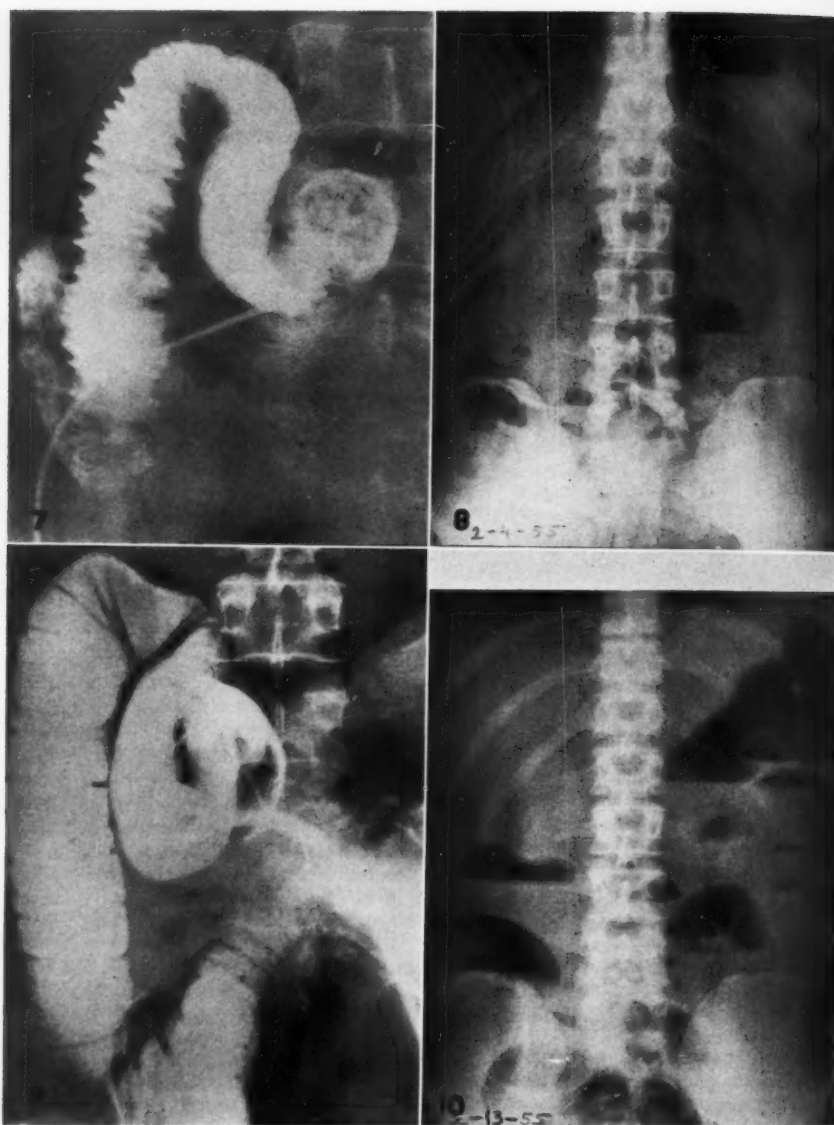
Over the ensuing three years, recurrent episodes of abdominal distress, distention and profuse ileal discharge necessitated frequent hospital admissions and visits to the emergency ward. Catheterization of the terminal ileum on these occasions usually provided considerable symptomatic relief.

Four days of progressive abdominal pain and distention, coupled with absence of ileal discharge, led to readmission in December 1952. At this time a finger tip could not be passed through the stoma. A small-intestinal enema (Fig. 7) revealed obstruction at the abdominal ring, together with moderate dilatation of the terminal ileum. Accordingly the old skin graft about the ileostomy was split and new skin was applied at the site of the incision. These procedures resulted in symptomatic relief lasting two years.

On Feb. 4, 1955, the patient was readmitted as an emergency after several weeks of back pain, nausea, vomiting, weakness, and excessive ileal discharge requiring ten changes of pads daily rather than the usual two. He was dehydrated and in shock. The blood pressure, which was 80/60 mm. Hg on admission, fell still further shortly thereafter, necessitating norepinephrine administration. A period of oliguria followed, lasting several days. Urinalysis on ad-

mission revealed 4+ albumin, 2+ bilirubin, and 4 to 8 white blood cells per high-power field. Seven days later, there was 1+ albumin, a trace of bilirubin, and 3 to 6 white cells per high-power field. Serum nonprotein nitrogen concentration on admission was 110 mg. per cent, rising to 176 mg. per cent on the tenth hospital day and gradually falling to 145 mg. per cent on the thirty-first day, and to 58 mg. per cent on the fifty-fifth day.

During the first few hospital days, the cause of the patient's difficulties was obscure, and acute adrenal insufficiency was seriously considered. A barium enema through the ileostomy, on the third day, showed moderate ileostomy dysfunction, with a suggestion of ileitis in the prestomal portion. These findings were not markedly different from those of December 1952, though the upright roentgenogram showed several small-intestinal loops in the mid-abdomen, moderately dilated and containing fluid and gas, indicating incomplete small intestinal obstruction (Figs. 8 and 9). On the tenth day, after several days of relative clinical remission, acute symptoms recurred, once again necessitating norepinephrine administration. At this time, however, there was classical clinical and roentgen evidence of low small-intestinal obstruction (Fig. 10). Miller-Abbott intubation relieved the distention and, with the institution of terminal-ileal catheterization via the ileostomy at regularly scheduled intervals, the ileal discharge became less profuse and the patient rapidly improved. A comparison of small-intes-



Figs. 7-10. Case IV.

Fig. 7. Barium enema through ileostomy, Dec. 12, 1952. It was difficult to pass the enema tube through the stoma. Moderate degree of ileostomy dysfunction is characterized by moderate dilatation of the prestomal loop and effacement of the circular folds in the terminal 15 cm. area.

Fig. 8. Feb. 4, 1955. Another episode of ileostomy dysfunction. Plain film of abdomen in erect position. Several slightly dilated, gas- and fluid-filled small-intestinal loops are seen in the midabdomen.

Fig. 9. Feb. 7, 1955. Enema through ileostomy. The prestomal loop is moderately dilated and the rugal pattern is abnormal.

Fig. 10. Feb. 13, 1955, nine days after Fig. 8. Roentgenogram (erect) showing multiple gas-crowned fluid levels in dilated small intestinal loops, indicative of low small-intestinal obstruction.

tinal enemas, *via* the ileostomy, on the twelfth and twenty-sixth days, documented roentgenologically the clinical evidence of improvement in function.

During the following two and one-half years, up to the present, the patient has had no untoward gastrointestinal symptoms and has been able to carry on his normal activities as a salesman. Urinalysis on Jan. 30, 1956, revealed 2+ albumin and 20 to 30 white cells per high-power field; serum nonprotein nitrogen was 47 mg. per cent. The present weight is 190 lb.

CASE V: F. O'C., a 41-year-old machinist, underwent ileostomy in February 1952 because of intractable ulcerative colitis. Since at operation the terminal 15 cm. of ileum showed the typical gross morphology of regional ileitis, resection was done and the stoma fashioned 45 cm. proximal to the ileocecal valve. The distal loop was drained as a mucous fistula.

During the following three months malnutrition developed, with marked weight loss (to 90 lb.), oral moniliasis, and ileal discharge, at times as profuse as 4 liters in twenty-four hours. There were frequent episodes of acute weakness, abdominal pain, distention, dehydration, and electrolyte depletion. Oral passage of barium on May 15, 1952, revealed nonspecific inflammatory disease of the small bowel as well as ileostomy dysfunction (Fig. 11). With nonoperative management the patient improved considerably over the next five months and gained 30 lb. On Oct. 14, 1952, the distal ileum (mucous fistula) and the colon down to the rectosigmoid were resected *en bloc*. The most proximal segment of the resected ileum was normal. There was, however, an abrupt transition from normal tissue to severe disease, manifested by pipe-stem narrowing, rigidity,



Fig. 11. Case V. Barium by mouth, six hours p.c. There is prolonged stagnation of barium in the markedly dilated lower ileal loops (bottom). Some barium is just entering the ileostomy bag (right midfield).

and a Y-shaped fistula communicating with the duodenum and with the hepatic flexure of the colon. Distention and cessation of the passage of flatus in the postoperative period required an emergency enterostomy. A small-intestinal enema through the ileostomy on Oct. 30 confirmed the presence of dys-

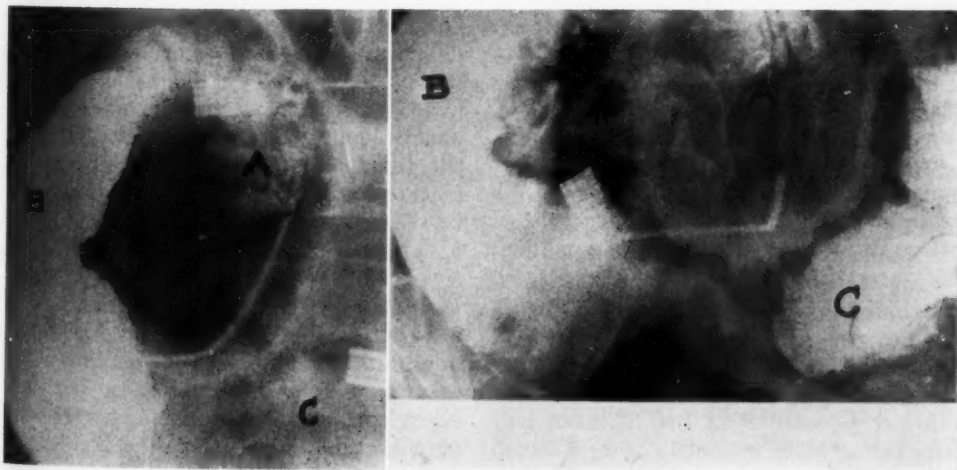


Fig. 12. Case V. Enema through ileostomy. Two stages during barium passage through the Foley catheter are shown. Identical loops are labeled by A, B, and C, respectively. The visible 45 cm. of the terminal ileum are markedly dilated, up to 5 cm., and the circular folds are completely absent.

TABLE I: ROENTGEN CHANGES IN FIVE CASES

Case	Width of Prestomal Ileum (cm.)	Kerkring's Folds		Oral Passage of Barium; Arrival at Stoma.
		Extension Above Stoma (cm.)	Type	
I	8.5	None	...	.....
II	4	10	Thick, short	More than five hours
III	5 to 9	8	Irregular, widely spaced	.....
IV	4.5 to 10	15	Thick, short	.....
V	5	None	...	More than six hours

function (Fig. 12). The ileostomy was therefore revised in November 1952.

No significant improvement occurred, and an acute exacerbation of symptoms led to a further revision of the ileostomy in March 1953. This notwithstanding, a fistulous tract appeared at the ileostomy margin. This fistula, together with another exacerbation of symptoms, led to the excision of 3 cm. of terminal ileum and the construction of a new stoma on April 23, 1953. Thereafter the patient improved rapidly. Although two minor operations, for ileostomy prolapse and for ventral hernia, were performed within the following few months, the patient has not been troubled by ileostomy dysfunction in the more than four years which have elapsed since April 23, 1953. His present weight is 149 lb., and he leads an active life as a shop foreman.

DISCUSSION

Roentgen evidence of small-intestinal obstruction of lesser degree revealed by a few moderately dilated, gas- and fluid-filled loops, best seen with the patient erect, is quite common in ileostomy dysfunction. Alone, however, these findings are often not diagnostic and may not permit the localization of the obstruction. The classical picture of small-intestinal obstruction of high degree is rather rare (Case IV, Figs. 8 and 10).

Barium studies in patients with ileostomy dysfunction, with introduction of the medium by mouth and through the ileostomy stoma, are best compared with the findings in subjects with a well functioning ileostomy. In subjects with dysfunction the prestomal ileum is markedly widened, the diameter ranging from 4 to 10 cm. (Table I). In contrast, in 13 patients with good function the ileum was found to be narrow (2.0 to 2.5 cm.) in 7 instances, slightly widened (2.5 to 3.2 cm.) in 5, and widened up to 4.0 cm. in 1 exceptional case of clinical well-being combined with roentgen evidence of ileal disease.

In subjects without ileal disease and with well functioning ileostomy, Kerkring's circular folds extend down to or almost to the stoma. In the patients with dysfunction, these folds, if present at all, are shorter, wider, and more widely spaced than normal. In no case did they reach the stoma, and in some instances they were entirely absent in the terminal loop. In none of the patients with ileostomy dysfunction were formed feces encountered in the prestomal ileum.

Oral administration of barium revealed gross delay in small-intestinal transit in the 2 ileostomy patients who were studied. Over five hours in one patient (Case II) and over six in the other (Case V) were required for barium to reach the stoma. These findings are in contrast with the normal small-intestinal transit seen in the presence of a well functioning ileostomy (5).

The foregoing roentgen findings are diagnostic of ileostomy dysfunction. Borderline conditions may occur, as illustrated by Figure 7 (Case IV). Here the prestomal loop is intermediate between the normal narrow loop with regular rugal pattern and the grossly dilated loop with complete effacement of all folds and retention of large liquid masses.

In contrast to the well defined and rather uniform roentgen criteria is the great variability of the clinical manifestations of ileostomy dysfunction. Although abnormality in ileal discharge, either profuse or scanty, is common to most patients, other signs and symptoms have suggested diverse etiologic bases for the difficulties in individual cases. In Case I, for example, upper gastrointestinal symptoms so dominated the clinical picture that psychogenic

vomiting and later cholecystitis and cholelithiasis were held responsible for the downhill course. Dramatic regression of symptoms was obtained, however, not by cholecystectomy but only after resection of a markedly edematous, inflamed, and ulcerated terminal ileal segment. In Case II, sodium and chloride depletion were so profound that Addison's disease was strongly suspected to be a major contributing factor. Here, too, health was restored after resection of the diseased ileum. In Case III, mental changes were so severe that schizophrenia was seriously considered to be the basis for the patient's failure to eat, and the resultant malnutrition, protein depletion, and anemia. With corrective surgery, abnormal intestinal losses of nutrients ceased, appetite strikingly improved, and the mental status rapidly reverted to normal.

The pathomechanics of the obstruction and the associated enteritis which give rise to the clinical manifestations of ileostomy dysfunction are complex and in all probability vary both from patient to patient and from time to time in any given patient. The propulsion of chyme is not effected solely by a peristaltic contraction of the circular smooth muscle of the intestine, analogous to the squeezing of tooth paste from a tube. Small-intestinal transport is a far more intricate process, in which the well developed longitudinal muscle also has a share. The functional adjustment of the intestine to the blunt implantation of ileum into the rigid abdominal wall is labile (3, 9), and the rigidity and lack of distensibility of the cutaneous and subcutaneous rings, as compared with the expansibility of the normal ileum, provide a predisposition to obstruction. Warren and McKittrick have found that late obstruction is in large measure due to scarring of the serosa of the exposed ileum (3), and Turnbull and Crile, following similar reasoning, have been able to avoid early and late complications of ileostomy by covering the serosal surface of the prestomal ileum with a mucosal graft (10, 11).

Obstruction, as considered here, is not

synonymous with morphologic narrowing or stricture. Obstruction, as a functional concept, is the result of a relative strait not capable of handling the amount of flow demanded at a given time: it is this disturbed flow that constitutes obstruction. A given caliber or ring may allow free passage to contents of a certain amount and consistency, passing with a given speed, which in turn is a function of the propelling force. The same morphologic set-up, approached by greater content or with a weaker propelling force, may act as an obstacle: this is obstruction. In the first instance the system is balanced or compensated; in the second it is decompensated (12).

While morphologic and motor abnormalities are revealed by the roentgenologic evidence, still other disturbances are added, possibly in a similar fashion as in the malabsorption syndrome. Improper eating habits, food idiosyncrasy, chemical, bacterial and viral irritation, emotional upsets mediated *via* the autonomic nervous system, and other factors may adversely influence the motility, secretion, and absorption of the small intestine. Any combination of these factors may increase the intestinal content or decrease the propulsive force, either directly or by way of edema and inflammation, thus turning the compensation into decompensation, or, in other words, creating obstruction without any change in the caliber of the stomal ring. The roentgen observations in Case III (Fig. 6) furnish an illustration of this relative obstruction. A forceful contractile wave was traveling toward the ileostomy and squeezing the intestinal content ahead of it. No barium, however, was seen to traverse the stoma. Forceful peristalsis, suggestive of intestinal obstruction, was also observed through the abdominal wall. In view of these findings, the obstruction was obviously at the stoma, even though this orifice readily admitted the tip of the index finger. Later pathologic examination showed a stoma 1.5 cm. in diameter, by no means narrow enough to prevent easy transit of liquid or semisolid intestinal con-

tent under otherwise normal conditions. Under the conditions prevailing at the time of examination, however, it was sufficiently narrow to cause obstruction.

The question arises as to whether the severe inflammatory changes observed in the prestomal ileum represent aggravation of residual disease or a new, nonspecific ileitis incident to imperfect function of the ileostomy and to stagnation. Involvement of the terminal ileum is known to occur in ulcerative colitis as coordinated disease or as "back-wash ileitis." In various series of patients with ulcerative colitis, the terminal ileum was involved in 1.3 to 40 per cent (3, 13-15). The importance of removing diseased ileum has been stressed and the healthy condition of the ileal stump should be ascertained by frozen section during operation (6, 14).

In the great majority of cases, however, the abnormalities in the prestomal ileum are not due to pre-existing disease but are nonspecific in nature, apparently the result of prestenotic stagnation, and are part of the syndrome of ileostomy dysfunction. Nonspecific ileitis has been shown to develop after an ileostomy, when microscopically normal terminal ileum could be demonstrated either at the initial operation (Case IV) or, subsequently, in the distal ileal loop left behind (12, 16). Moreover, the pathologic changes usually associated with regional ileitis are not found in the prestomal loop (Cases I and III) (12, 16). Further support of the nonspecific nature of this prestomal ileitis is furnished by the observation by Dennis and Karlson (7) of ascending enteritis developing in patients in whom ileostomy was performed for polyposis (a noninflammatory disease), and by the oft-noted development of severe inflammatory and ulcerative processes in the colon proximal to an obstructing carcinoma (6, 17, personal observations). On the other hand, it is to be expected that, with incomplete resection, residual disease may become worse and extend, especially under the unfavorable conditions of stagnation in the presence of a poorly functioning ileostomy.

It is noteworthy that ileostomy dysfunction may occur at any time in the life of these patients, no matter how many asymptomatic years have elapsed since the last episode of difficulty. In Case IV, for example, following a minor stomal revision, the patient was asymptomatic for a period of two years. Then, for no apparent reason, excessive ileal discharge and other manifestations of an obstructive process developed, leading to shock. This, in turn, resulted in oliguria and azotemia, to which underlying renal disease may also have contributed.

In the clinical management of ileostomy dysfunction, both medical and surgical measures play important roles, and it is often difficult to determine initially whether nonoperative management will prove satisfactory. Often the findings of a single roentgen examination will not permit distinction between progressive chronicity and reversibility of the process or allow any conclusion as to whether non-surgical measures will restore compensation. In Case III, for example, clinical and roentgen evaluation led to the adoption of a program of regular digital dilatation of the stoma and catheterization of the terminal ileum, a regimen which failed to stop the downhill course. After resection of only 5 cm. of diseased ileum and reconstruction of a new ileostomy the patient rapidly regained good health. In contrast, it is sometimes possible to restore, even in cases of severe ileostomy dysfunction, an acceptable balance without operative intervention. In Case IV, for instance, where the ileostomy dysfunction resulted in severe depletion, complete intestinal obstruction, and vascular collapse, it was possible to restore compensation by intestinal drainage from above and below, accompanied by supportive medical treatment, and in the two and one-half years which have elapsed since these measures the patient has been in good health.

SUMMARY

Ileostomy dysfunction constitutes an ever present threat to patients with an

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ileac stoma. The histories of 5 patients with severe ileostomy dysfunction are presented. The etiology of ileostomy dysfunction and measures for its prevention and alleviation are discussed.

In a well functioning ileostomy the transit through the small intestine occurs in normal time. A barium enema introduced through the ileostomy shows the prestomal loop to be normal in width and Kerkring's folds to extend down to or almost to the stoma.

In a patient with ileostomy dysfunction the roentgen signs of incomplete or, more rarely, complete intestinal obstruction are often present on plain roentgenograms, in supine and erect position. If barium is given by mouth, the small intestinal transit is grossly delayed. Barium enema through the ileostomy, the most helpful examination, reveals widening of the terminal ileal loop, harboring increased amounts of liquid content. Kerkring's folds are abnormal or absent. This examination also demonstrates the obstructive narrowing at the cutaneous or subcutaneous level of the ileostomy.

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SUMMARY IN INTERLINGUA

Observationes Roentgenologic De Ileostomias In Patientes Con Idiopathic Colitis Ulcerative II. Dysfunction Del Ileostomia

Dysfunction ileostomic es un menacia semper presente pro patientes con ileostoma. Es presentate le historias de 5 patientes con sever grados de dysfunction ileostomic. Es discutate le etiologia del dysfunction de ileostomias e le mesuras a prender pro prevenir e alleviar iste condition.

In un ben-functionante ileostomia le transito per le intestino tenue occurre in un tempore normal. Un clyster a barium introduce via le ileostomia monstra que le ansa prestomal es normal in su largor e que le plicas de Kerkring se extende in basso usque a o quasi usque al sito del stoma.

In pacientes con dysfunction ileostomic le signos roentgenographic de incomplete o (minus frequentemente) de complete obstruction intestinal es frequentemente visualisable in roentgenogrammas simple in position supin o erecte. Quando barium es administrate per via oral, le transito per le intestino tenue es grossiermente retar-

date. Clyster a barium via le ileostomia—le plus utile forma de examine—revela un allargamento del ansa terminal del ileum e in illo un augmentate contento de liquido. Le plicas de Kerkring es anormal o absente. Iste examine etiam demonstra le restriction obstructive al nivello cutanee o subcutanee del ileostomia.



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Outline of Probable World Requirements of Cobalt 60 for Therapy Machines¹

R. F. ERRINGTON, M.A.²

THE FIRST kilocurie cobalt-60 therapy machines were produced and installed in Canada in the Fall of 1951, one at Saskatoon, Saskatchewan, and one at London, Ontario. Since that time there has been a steady and continuous increase in the number of machines in service, and hence in the number of patients receiving treatment.

This expansion in experience with cobalt machines has produced numerous papers and much healthy discussion concerning the best type of design and the best techniques of treatment. It has also produced speculation on the probable extent of future requirements for cobalt machines. This speculation is desirable, both on the part of radiologists and physicists who will use the machines, and on the part of manufacturers who will produce them. An exchange of opinions should help to keep things in balance. It will be recalled that the balance between supply and demand was out of phase for several years due to a world shortage of high-specific-activity cobalt 60.

As one associated with the production of cobalt 60, I shall try to examine the extent of past and probable future uses of these machines with particular reference to the adequacy of expected supplies of the isotope. During the early stages, production of cobalt in the United States was small and production in Canada depended entirely on the NRX reactor. I suppose some of us in Canada thought we had stolen a march on our good neighbors in the United States and other countries. On Dec. 12, 1952, however, it was reported that a "pin hole" had developed in the NRX reactor, necessitating a shutdown for repairs. This "pin hole" proved to be of a very cantankerous nature, since it required a year or so for repair. Production in the

United States was still on a modest scale, and consequently many hospitals had to wait for long months to get their cobalt machines installed; others may have wondered where a replacement source would come from if they went ahead. There may be those who now wonder whether this is the kind of thing that could happen again. I shall try to produce some facts and assumptions which should provide an answer to this question.

There are a number of methods of approach to this problem of trying to determine whether the future supply of cobalt 60 will be adequate to the needs of therapy. One could simply plot the number of machines installed each year and attempt to extrapolate the graph into the future. I have collected (as best I could) such figures and these are shown in Figure 1. Would anyone dare to extrapolate that curve for four or five years without some other considerations?

Perhaps I should explain that in all of these discussions on the amount of cobalt required, and the expected production, I have in mind the world total with the exception of the USSR and satellite areas. There is some information available on Soviet production, but I do not know whether it is reliable.

I have chosen to begin with an estimate of the number of machines which might reasonably be in service by the end of 1961, and to work backwards, deriving the amount of cobalt 60 necessary to equip and maintain these machines. The results are, therefore, no more accurate than the estimates and assumptions.

A brief questionnaire was sent to eleven people in the United States and Canada to get a starting point. Since there was fair agreement among the estimates received,

¹ Presented as part of a Symposium on Cobalt Therapy at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

² Commercial Products Division, Atomic Energy of Canada, Ltd.

they have been averaged. The results are as follows:

1. Number of equipments in world service by the end of 1961.....1,200
2. Average number of curies in each equipment.....1,220
3. Average price per machine (excluding source).....\$23,000

plotted on probability paper, a straight line results. The slope of the straight line is quite independent of the magnitude of the growth. Rather, it indicates only the period of time during which most of the increase takes place. I have assumed that the number of installations made in 1951 was 1 per cent of maximum, and that those

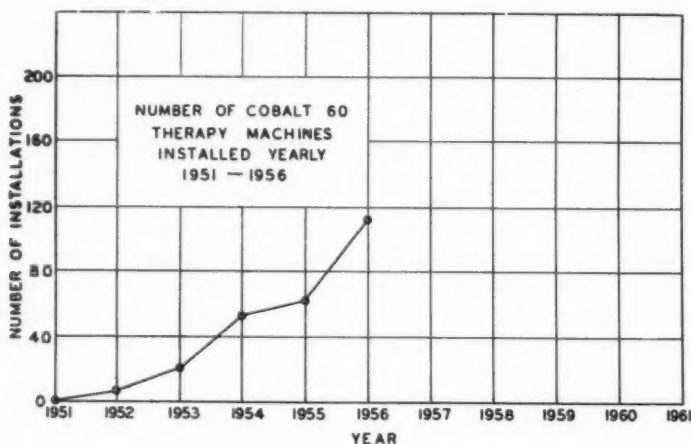


Figure 1

The price figure is included only to indicate the expected size and complexity of the average machine.

This gives us some idea of the total number of machines we may expect to see in service four years from now, having regard for other established methods of treating cancer. The whole basis of this paper would, of course, be changed in the fortunate event of the discovery of a vaccine type of cancer control.

The next question is how many machines will be installed each year. Many new products and processes are accepted and put in service according to a statistical growth curve. I have assumed that this will be true in this case, partly because I consider it probable, and partly, I suppose, because I know of no other mathematical approach.

A growth curve rises slowly at first, then more steeply, and finally flattens out at the top. If the ordinates are expressed as a percentage of the upper asymptote and

TABLE I: NUMBER OF COBALT-60 THERAPY MACHINES PLACED IN SERVICE AND LIKELY TO BE PLACED IN SERVICE, 1951-1961

Year	Per Cent of Maximum	Number of Machines Installed	
		Estimated	Actual
1951	1	2	2
1952	4	7	7
1953	12	22	21
1954	28	52	54
1955	50	92	60
1956	72	133	113
1957	87.5	162	...
1958	96	177	...
1959	99	183	...
1960	99.8	185	...
1961	100	185	...

made in 1959 will be 99 per cent of maximum, with subsequent years at a fairly uniform rate. The straight line through these two points permits one to determine by inspection the probable number of machines to be put in service each year if the total by 1961 is to be 1,200, as assumed above.

The probability curve so derived is shown in Figure 2. The circles represent

TABLE II: COBALT-60 REQUIREMENTS FOR THERAPY

Year	Estimated Number of Equipments	Cobalt 60 Required (Kilocuries)		
		New Equipments	Replacement	Total
1951	2	2	...	2
1952	7	9	...	9
1953	22	27	2	29
1954	52	64	6	70
1955	92	112	17	129
1956	133	162	36	198
1957	162	198	64	262
1958	177	216	97	313
1959	183	224	134	358
1960	185	226	170	396
1961	185	226	211	437

the actual results from 1951 to 1956. There is some measure of agreement, although perhaps the actual rate of growth is a little slower than that assumed.

On these assumptions, the number of machines most likely to be placed in service each year are shown in Table I. In this table, it should be noted that the figures under "Actual" may be subject to some error, although it is believed that they are sufficiently accurate for our purpose. These figures which now make up the growth curve have been plotted on ordinary scale. They are to be seen in Figure 3.

It will be noticed that the actual number of installations (plotted as circles) shows some correlation with the theoretical curve. The number of installations made in 1955 and 1956 was certainly held down by cobalt-60 shortages. It is, however, apparent that the actual rate is somewhat less than the theoretical rate.

It now becomes relatively simple to calculate the amount of cobalt 60 required to equip and maintain the above number of machines. This is shown in Table II. Table II is based on theoretical requirements. Actual requirements to date have been somewhat less. Cobalt required for replacement of decayed sources is based on 17 per cent per annum of the cumulative amount in service at the end of the prior year. This provides for scrapping of most of the therapy sources after a five-year decay period.

The actual production of cobalt 60 (in

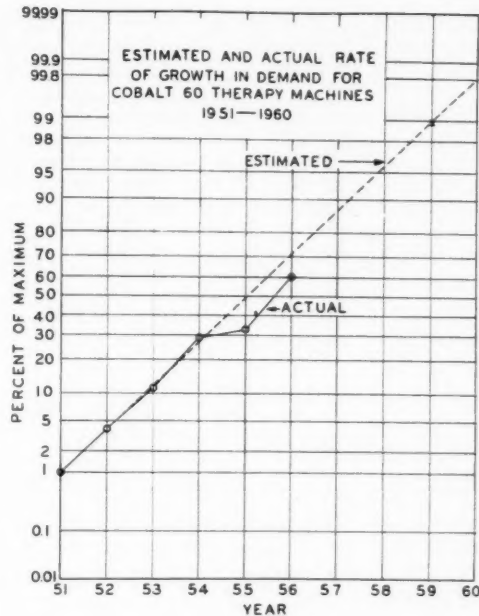


Figure 2

TABLE III: PLANNED PRODUCTION (KILOCURIES) OF HIGH-SPECIFIC-ACTIVITY COBALT 60

Year	United States	Canada	United Kingdom	France	Total
1951	...	2	...	...	2
1952	3	8	...	...	11
1953	6	13	...	...	19
1954	20	20	...	...	40
1955	20	25	...	...	45
1956	57	45	...	...	102
1957	275	110	...	...	385
1958	275	370	30	...	675
1959	275	370	30	20	695
1960	275	370	30	20	695
1961	275	370	30	20	695

round figures) and the scheduled future production are shown in Table III. It should be noted that this represents the expected future production as now planned and announced. It might be reasonable to assume that additional reactors, either in the countries shown or in other countries, will be producing suitable cobalt before 1961. Certainly, under normal circumstances, the amounts which could be produced are much greater than the amounts planned. We must conclude that even the planned production between

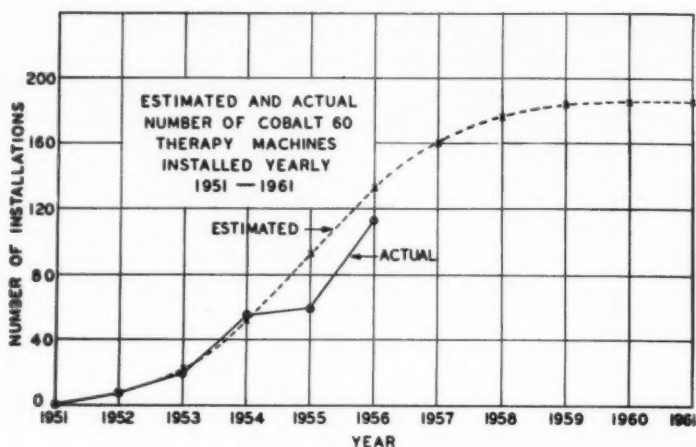


Figure 3

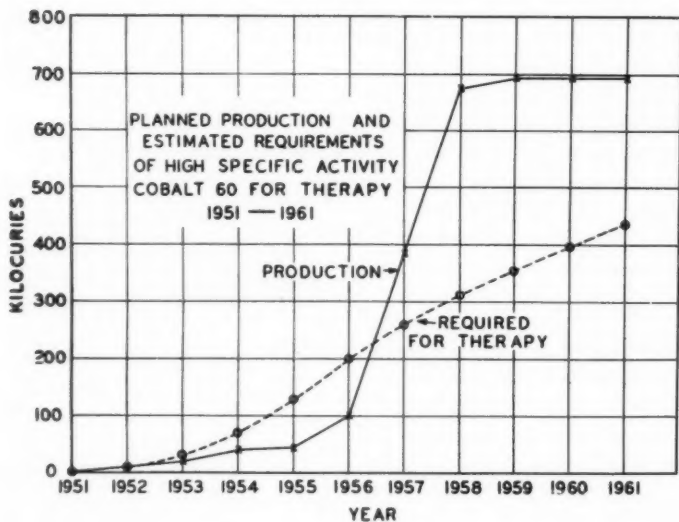


Figure 4

1957 and 1961 is very much greater than the expected requirement for therapy.

Production and expected requirements of cobalt 60 are plotted in Figure 4. In each year, up to and including 1956, the supply was inadequate and delay in delivery resulted. In 1957, with increased production in both Canada and the United States, the supply was more than adequate, and over the forecast period to 1961 there is a very large indicated surplus.

On the basis of this projection in the

growth of cobalt machine usage, the rate of cobalt production in 1958 will still be quite adequate to the rate of demand by 1968. At that time, we assume, something like 2,500 machines will be in service. In addition, there is every indication that the so-called theoretical growth of cobalt machines in use is more in the nature of a maximum than a true indication of what may happen. There are other considerations in the cobalt supply picture. Caesium 137 will play some part in the tele-

therapy field. Reactors not yet built will no doubt contribute to additional supplies of cobalt. Industrial requirements can be serviced to a considerable extent by comparably large production of low specific activity cobalt not considered in the above figures.

Since the total of production is coming from quite a number of reactors, the possibility of short supply due to reactor shutdown appears remote. It therefore seems that we need have no worries about sup-

plies of cobalt to equip new machines, or renew sources in old machines, at least for the foreseeable future.

NOTE: I acknowledge assistance, in obtaining information on production plans, of Dr. Paul C. Aebersold of the United States, Mr. Denis Willson of the United Kingdom, and Mr. Fisher of France. I would also like to thank, anonymously, those who assisted by completing the questionnaire on the number of machines expected to be in use.

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SUMMARY IN INTERLINGUA

Le Probabile Requirimentos Mundial De Cobalt⁶⁰ Pro Machinas De Therapia

In vista del currente speculationes relative al magnitudine futur del requirimentos del therapia a cobalt, un examine esseva facite del usos passate e del probabile usos futur de machinas a cobalt⁶⁰, con referentia particular al adequatia del expectate disponibilitate del isotopo. Le numero del machinas in servicio in 1961 es estimate a 1,200 e le numero medie de curies per machina a 1,220. Super le base de datos relative al installationes in servicio inter

1951 e le presente e al estimate installationes futur, determinationes es facite in re le numero probabile de machinas ponite in servicio per anno e in re lor requirimentos de cobalt. Considerante le production currente de cobalt⁶⁰ e le planate production de illo in le futuro, il pare que un adequate provision del isotopo pro equipar nove machinas e pro renovar le fontes de radioactivate in machinas jam in uso es assecurate pro le proxime futuro.



A Comparison of a Cobalt-60 Teletherapy Unit and a 2-MEV Van de Graaff X-ray Generator on the Basis of Physical Measurements¹

K. C. TSIEH, M.A., and ROBERT ROBBINS, M.D.

SINCE THE FIRST 1,000-curie cobalt-60 therapy unit was installed at the University Hospital in Saskatoon, Canada, in August 1951 (9, 10, 27), such installations have become increasingly in demand, as well as in existence. As Dr. J. E. Roberts stated editorially in 1952, "there is clearly no clinical or physical magic about the large cobalt unit. In its simplest form it offers a source of penetrating radiation very similar to a 2- or 3-MEV x-ray unit without the problems of high-voltage supplies, tubes and complex electrical equipment, but with, of course, some problems of its own" (19).

At present there are a number of different types and models of the cobalt unit. The electrical x-ray machines in the equivalent energy range are mainly of three types: the 1- to 2-MEV resonant transformer x-ray generator; the 4- to 8-MEV linear accelerator, and the 2-MEV Van de Graaff electrostatic generator. The cost of installation of the first two is comparatively higher than that of the Van de Graaff generator.

The construction and installation of an electrostatic generator for the treatment of cancer were reported as early as 1937 by Dresser, Trump and Van de Graaff at the Collis P. Huntington Memorial Hospital, Boston (4). The physical measurements have been reported by Trump and his group in a series of papers mainly during the period of 1940-51 (20-26). More recently, during the period 1950-53, the use of the Van de Graaff generator in therapy, as well as the results of physical measurements, have been reported from England by Miller and his group at Sheffield (7, 15), Wilson and Perry at Westminster Hospital

(29), and Wheatley and others at the Royal Marsden Hospital (28).

During the early part of 1957, the first new model AM Van de Graaff x-ray generator with sealed tube and other modifications was installed in the Department of Radiology, Temple University Hospital, Philadelphia. In this unit, the vacuum system attached to the generator has been eliminated. The installation of the Van de Graaff generator closely followed that of a 1,000-curie cobalt teletherapy unit (Picker C-1000) in the latter part of 1956. Before the treatment of patients was scheduled, physical measurements of both machines were undertaken with the aim of determining the dosage in clinical application. The installation of these two therapy machines around the same time has made possible a close comparison of the data which are presented here. The advantages of high-energy x-rays over the conventional 250-kv x-rays in deep therapy are well known and will not be discussed.

SIZE AND DEFINITION OF THE BEAM

The geometrical properties of the beam are important to the therapeutic application of x-rays. A well defined beam is always desirable. A large field size should be obtainable at a distance with an adequate output. These conditions are determined by the size of the source, or focal spot, the design of the collimating system, and the optimal target-skin distance to be used. The output of the cobalt unit at Temple University is adequate for treatment with a target-skin distance of 40 to 60 cm., and the output of the Van de Graaff generator for a treatment distance of 100 cm.

¹ From Temple University Medical Center, Philadelphia, Penna. Presented as part of Symposium on Cobalt-60 Therapy at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

The larger the source size, less well defined the beam, and the shorter the distance from the collimator to the irradiated surface, the better the definition of the beam. In the energy range considered, however, in order to avoid secondary electron irradiation from the collimator, the distance from the latter to the skin should not fall below a minimum of 20 cm. (7, 11). The collimating system of the cobalt unit is made up of interlocked lead pieces with a smaller opening near the source and a larger opening at the other end. The end of the collimator extends 27 cm. beyond the source, which means that at a source-skin distance of 50 cm. the collimator-to-skin distance is 23 cm.

The source in our cobalt unit is 2 cm. in diameter. With so large a source, the irradiated region is no longer sharply defined, but gives an effect commonly described as the penumbra. The generally accepted meaning of the field size becomes less clear. Even the geometrical width of the penumbra in itself has really little meaning, especially with x-rays when scattered radiation is present. The dose distribution in the irradiated region must be known.

In a number of institutions at the present time, the field size has been given by definition as the region enclosed by certain percentage isodose lines in the plane of maximum dose. Some institutions, for instance, adopt the 90 per cent line for definition of field size and some adopt 50 per cent; still others recommend the 80 per cent line. Actually the choice of the isodose line to be adopted as defining the field size is arbitrary, as there is little evidence to support the belief that one is better than another. The use of the 50 per cent line, however, may give the user a false impression that he can obtain a larger maximum field size than if the 90 per cent or 80 per cent line were used. Whenever the field size for the cobalt unit is mentioned, it can, of course, be clearly defined, but some agreement as to the meaning of terms used is always advisable.

For the cobalt unit, measurements have

**PARTIAL DOSE DISTRIBUTION IN THE PLANE
5 MM. UNDER THE SURFACE AND
PERPENDICULAR TO THE BEAM AXIS**

$\text{Co } 60$, (PICKER C-1000)

TSD 50 CM

COLLIMATOR SETTING 10 X 10 CM.

SOURCE DIAM. 2 CM.

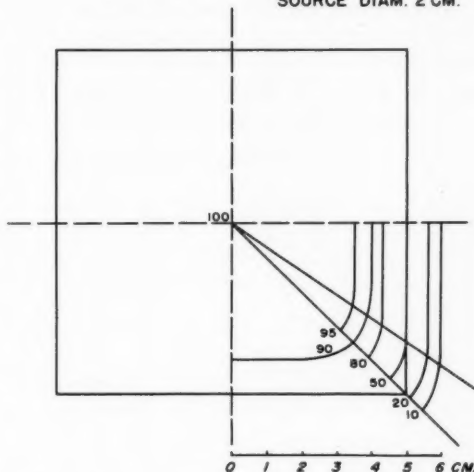


Fig. 1. Dose distribution in the plane 5 mm. under the surface and perpendicular to the beam at collimator setting 10 X 10 cm. and T.S.D. 50 cm. for the Picker C-1000 cobalt unit, source size 2 cm. diameter.

been made of the dose distribution in the plane of maximum dose, *i.e.*, 5 mm. under the surface, for different collimator settings. Figure 1, for example, shows the dose distribution at 10 X 10 cm. collimator setting and T.S.D. 50 cm. The lengths covered by the 90 per cent, 80 per cent, 50 per cent, 20 per cent, and 10 per cent isodose lines along the midaxis of square fields of different collimation settings were measured and are given in Figure 2. These curves are used as a guide for selecting the collimator opening in treating patients.

One interesting fact shown in Figure 2 is that the curves for 10 per cent, 20 per cent, and 50 per cent isodose levels are all straight lines. In other words, the lengths covered by 10 per cent, 20 per cent, and 50 per cent are directly proportional to the size of the collimator opening, but the 80 per cent and 90 per cent curves are concave and the lengths covered are less than an-

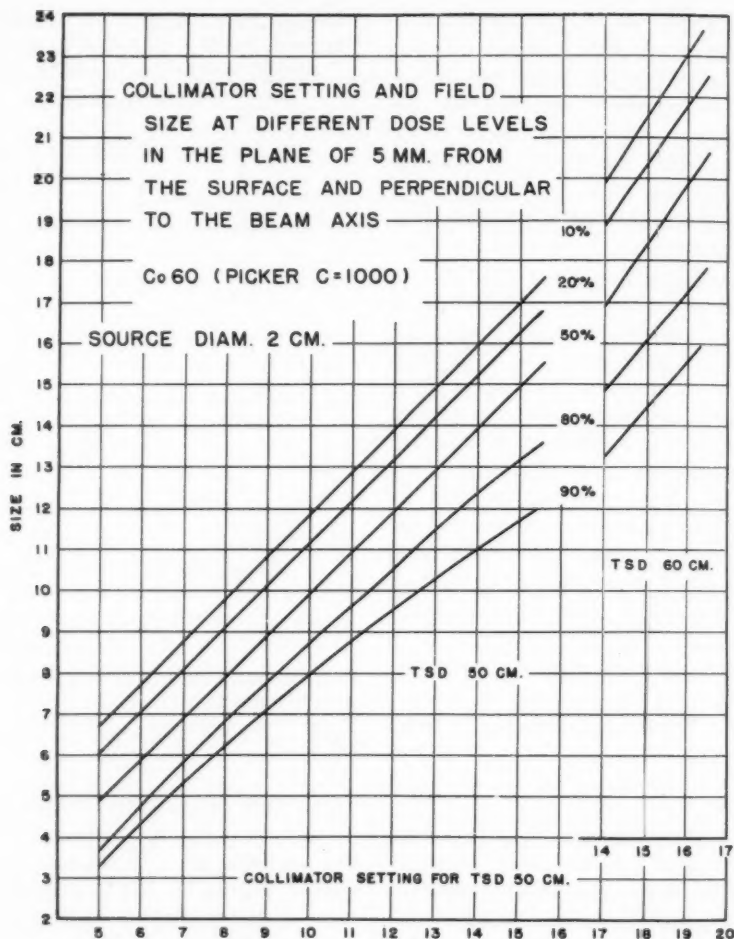


Fig. 2. Lengths of different dose zones at various collimator settings along the mid-axis in the plane 5 mm. under the surface and perpendicular to the beam for the cobalt unit.

ticipated by the linear relationship at larger collimator openings. This fact shows that the dose distribution becomes less even when the irradiated surface becomes larger. It further illustrates that the geometrical width of the penumbra alone does not adequately indicate the true dose distribution.

From the results shown in Figure 2, it was observed that the indication on the collimator setting in the cobalt unit studied corresponds to the size of the field enclosed by the 50 per cent isodose line. This has been confirmed subsequently by the original designer of the unit. In the following

paragraphs, the field size stated for the cobalt unit refers to the collimator setting.

The size of focal spot of the new model Van de Graaff generator based on the focal-spot film taken by the High Voltage Engineering Corporation's focal-spot scanning camera can be considered as approximately 2×3 mm. The size is considerably less than that previously reported by other workers: 9 mm. by Wootton (30) and 5 mm. by Howarth *et al.* (7). With such a small focal spot, the beam is well defined. The meaning of field size for the Van de Graaff generator therefore does

not raise the same problems as for the cobalt unit.

The collimating system of the Van de Graaff generator consists of two pairs of 3-inch lead blocks, one pair on top of the other. Each block in one pair can be moved away or toward the other by a control knob outside the collimator. The movements of these two pairs are perpendicular to each other.

The aperture near the target through

gens per minute, as the energies of the radiation from both machines are still within the range recommended by ICRU for this unit of measurement (16). The exposure dose rate was measured with a Victoreen thimble chamber with a Lucite cap for building up the electron equilibrium. The chamber was calibrated with cobalt-60 radiation. The same correction factor for the chamber was used in the measurements of both sources.

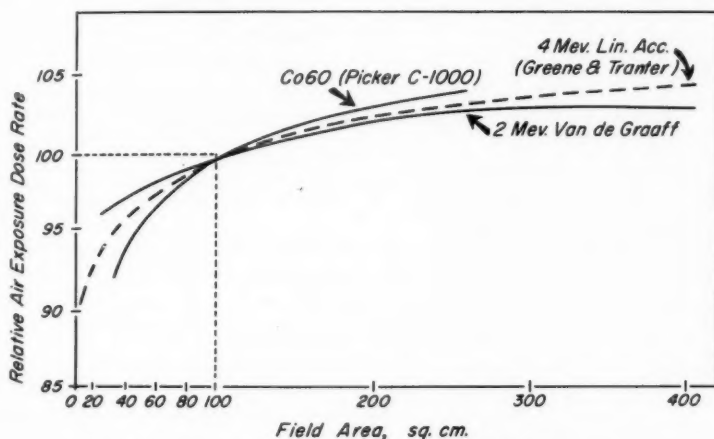


Fig. 3. Variations of air exposure dose rate with field area.

which the x-rays pass is a cone-shaped hole through a primary lead barrier. When the opening between the lead blocks is too large, the corners of the irradiated field become rounded. The largest field sizes obtainable are as follows:

Largest perfect square field: 23.5×23.5 cm.

Largest perfect rectangular field: 30×14 cm.

Largest field: 30 cm. along the midaxes of the field and 33 cm. along the diagonal axes.

THE OUTPUT

In the first stage of physical measurements, the effects on the output of radiation by all relevant factors were determined. These factors are field size, distance, beam current, and voltage. The last two apply to the Van de Graaff generator only. The output of both the cobalt unit and the Van de Graaff generator is expressed as exposure dose rate in air, at electron equilibrium condition, in roent-

Variations of Exposure Dose Rate with Field Size: The air exposure dose rates were measured at different field sizes for both the cobalt unit and the Van de Graaff generator. The relative values were obtained by taking the dose rate at the field size 10×10 cm. as 100. The results are shown in Figure 3. The variations of exposure dose rate with field size have been reported for other supervoltage equipment, such as the Eldorado cobalt unit by Dixon *et al.* (3), and the 4-MEV linear accelerator by Greene and Tranter (6). The variations all follow curves of the same type, but in different degrees. It was also found that the variations are nearly independent of the T.S.D.

These variations are due to the gamma-ray scattering from the collimating system and the air volume in the path of the beam. The magnitude of variation is quite appreciable for small fields, so that correc-

tions should be made for the output at the actual field size in use as against the output at the field size measured.

Variations of Exposure Dose Rate with T.S.D.: The relationship of output and distance for the cobalt unit does not follow

1.00. The deviation from the inverse-square law is greater in the second case.

The variations of exposure dose rate with T.S.D. for the Van de Graaff generator are found to follow the inverse-square law very closely.

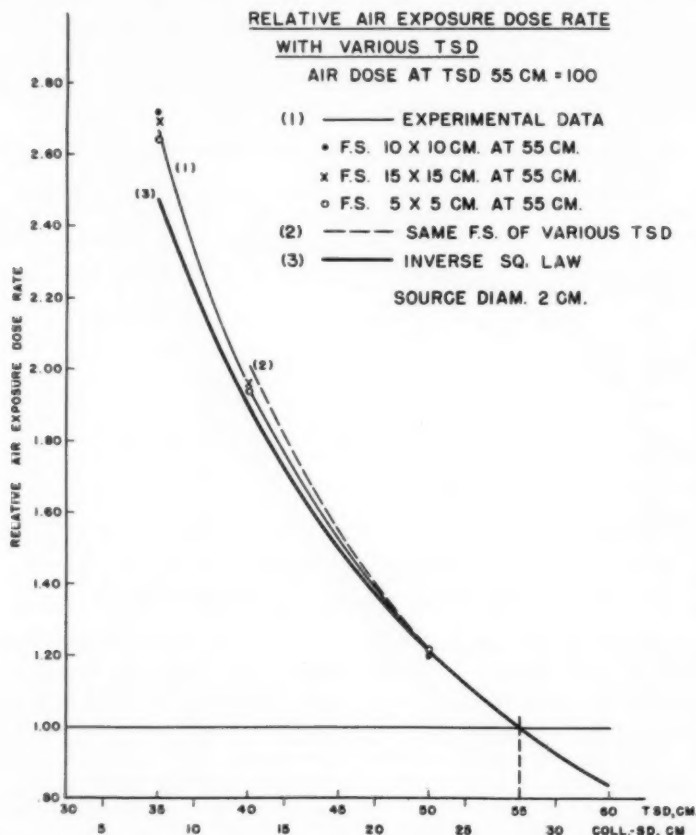


Fig. 4. Variations of air exposure dose rate with the target-skin distance for the cobalt unit.

closely the inverse-square law, which is expected. The measurements were made in two ways: (1) keeping the opening of the collimator constant when the distance was varied; (2) keeping the field size at the surface constant for all target-surface distances. In the second case, the opening of the collimator was increased as the distance from the source was made shorter. The relative exposure dose rates at different conditions are shown in Figure 4, where the values at T.S.D. 55 cm. were taken as

Variations of the Output with the Beam Current and Voltage of the Van de Graaff Generator: The output of the Van de Graaff generator has been found to be directly proportional to the beam current applied. The relative exposure dose rate at different beam currents is shown in Figure 5. In these measurements, the voltage was calibrated at 2 MEV when the generator was in a vertical position. In a horizontal position, the output becomes lower. This is because, in a horizontal po-

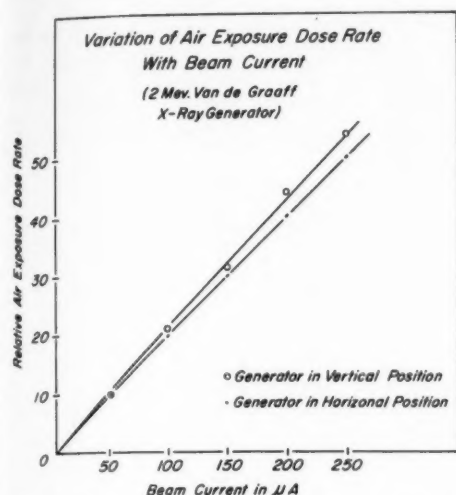


Fig. 5. Variations of air exposure dose rate with the beam current for the Van de Graaff x-ray generator.

sition, the column in the tank becomes deflected toward the generating voltmeter, giving the same indication on the meter for an actually lower voltage. It has been found that, when the generator is between 45° and horizontal, 2.05 MEV on the voltmeter indicator corresponds to 2 MEV in a vertical position.

The change of the output with voltage is rather rapid. From our measurements, the output is found to be proportional to the 3.25th power of the voltage between the range of 1 to 2 MEV (Fig. 6), which is in the same range as findings by Trump (20) and by Miller (15).

The Van de Graaff generator is equipped with a dose integrator, which is connected to a ring-shaped ionization chamber near the target. It has been found that the dose readings on the meter are not in linear relationship with the beam current; in other words, not linear with the output. The results are shown in Figure 7. The dose reading of the meter would be true only under the specific conditions at which it was calibrated. The conditions include voltage, beam current, T.S.D., field size, air exposure dose or tissue dose. The usefulness of such an integrator is rather limited. In our Van de Graaff, this meter has been converted to a dose-rate monitor for

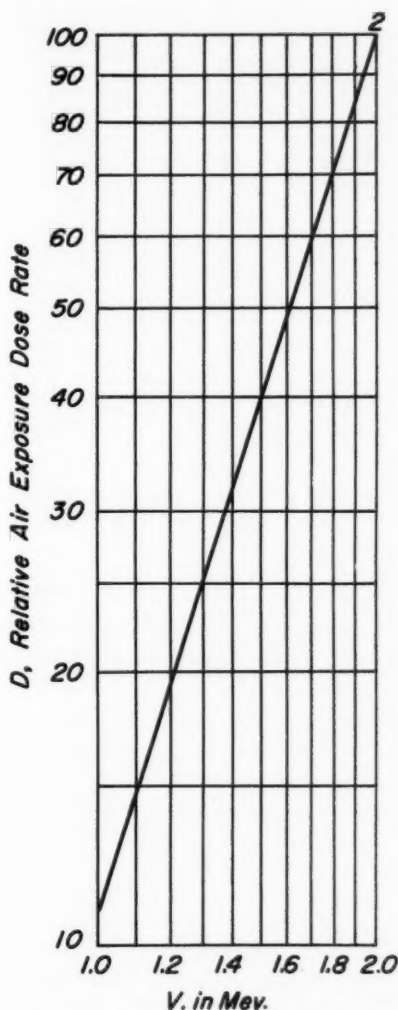


Fig. 6. Variations of air exposure dose rate with the voltage for the Van de Graaff x-ray generator.

indicating any abrupt changes of output in the daily operation of the generator.

THE CENTRAL AXIS DEPTH DOSE

In the second stage of measurements, the relationships between the central-axis depth dose, the thickness of overlapping tissue, and the field size were determined.

The central-axis depth dose may be expressed in two ways. In one, the target-surface distance is kept constant and the measuring point is moved further and fur-

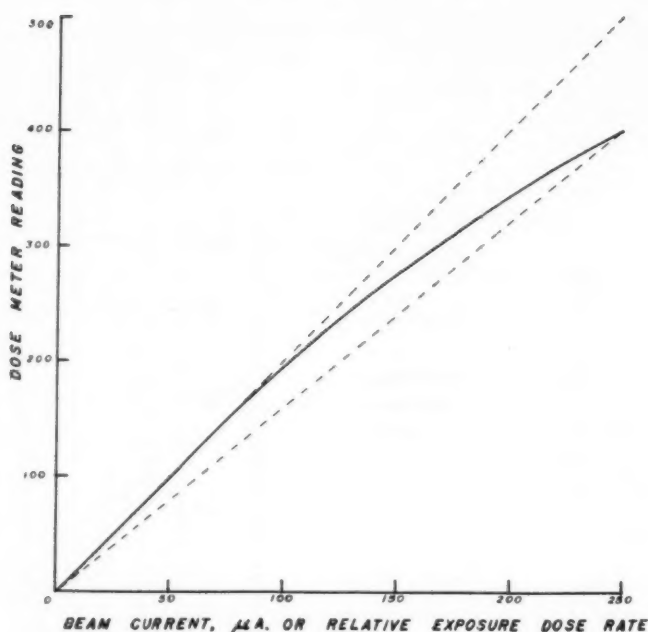


Fig. 7. Variations of dose meter reading with the beam current for the Van de Graaff x-ray generator.

ther away from the irradiated surface when the measurements are undertaken. Depth-dose tables are generally expressed in this manner. In the other, the distance from the target to the measuring point is kept constant and the absorbing material is increased in thickness during the measurement. The dosage data obtained by this method and corrected for the back-scatter factors give the so-called tumor-air ratios used in rotation dose calculation. But in some institutions the tumor is kept at a fixed distance from the target for stationary field treatment; here the tumor-air ratios would also be used in dose calculation.

The central-axis depth doses determined by both methods are presented in this paper. The measurements were made in a tissue-equivalent wax Mix "D" phantom with the 3-mm. diameter ionization chamber of Fedoruk and Johns design (5). The back-scatter factors for both the cobalt unit and 2-MEV Van de Graaff generator will, however, be discussed first.

The Back-scatter Factors: The scattered radiation at the energy range considered

here is mainly in a forward direction and back-scatter is small, but nevertheless appreciable. Table I presents in summary the back-scatter factors for large field sizes for both the cobalt unit and Van de Graaff generator given in the literature to

TABLE I: COMPARISON OF BACK-SCATTER FACTORS

Investigators	Field Size	Back-scatter Factor (%)	Method
2-MEV Van de Graaff, h.v.l. 12.5 mm. Cu			
Trump, Mos- ter, and Cloud, 1947 (23)	Not stated	3	Experimental
Lamerton, 1948 (13)	Infinite	8-9	Theoretical
Miller, 1950 (15)	Very big	5	Experimental
Tsien and Robbins, 1957	20 × 20 cm.	5.6	Experimental
Cobalt 60			
Corner and Liston, 1950 interpolated by Dixon <i>et</i> <i>al.</i> (3)	Infinite	5-6	Theoretical
Dixon, Gar- rett and Morrison, 1952 (3)	20 × 20 cm.	4.7	Experimental

TABLE II: CENTRAL AXIS DEPTH DOSE: 2 MEV VAN DE GRAAFF X-RAY GENERATOR
(h.v.l. 12.5 mm. Cu or 7.5 mm. Pb. T.S.D. 100 cm.)

Depth (cm.)	Field Area (sq. cm.)								
	0	20	35	50	80	100	150	200	400
0.3-0.4 B.F.*	100.0	101.8	102.5	103.0	103.7	104.0	104.6	104.9	105.6
0.3-0.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	94.0	96.2	97.0	97.1	97.3	97.4	97.6	97.9	98.0
2	86.4	90.5	91.9	92.5	93.0	93.2	93.9	94.3	94.8
3	79.5	84.5	86.1	87.2	88.4	88.8	89.7	90.0	90.5
4	72.8	78.2	80.0	81.4	83.0	83.5	84.5	85.1	85.5
5	66.9	72.3	74.4	76.0	77.7	78.5	79.6	80.6	81.0
6	61.3	66.7	68.8	70.6	72.7	73.3	74.5	75.8	76.6
7	56.2	61.5	63.4	65.4	67.7	68.6	70.2	71.6	72.5
8	51.6	56.7	58.6	60.5	63.1	64.5	66.0	67.4	68.6
9	47.5	52.3	54.2	56.0	58.8	60.2	62.1	63.5	64.9
10	43.5	48.2	50.1	51.9	54.7	56.3	58.1	59.7	61.4
11	39.9	44.4	46.2	48.1	50.9	52.6	54.3	55.8	57.9
12	36.6	40.9	42.8	44.6	47.3	49.0	50.7	52.3	54.2
13	33.6	37.7	39.6	41.3	44.0	45.6	47.5	49.1	51.1
14	30.9	34.8	36.7	38.2	41.0	42.5	44.4	46.1	48.0
15	28.2	31.9	33.8	35.4	38.0	39.7	41.5	43.1	45.0
16	26.0	29.5	31.5	33.0	35.3	36.8	38.9	40.6	42.2
17	23.9	27.3	29.0	30.4	32.9	34.4	36.2	37.9	39.8
18	21.9	25.1	26.9	28.3	30.6	32.0	33.9	35.6	37.3
19	20.1	23.2	24.8	26.2	28.4	29.9	31.7	33.3	35.1
20	18.5	21.4	23.0	24.3	26.5	27.9	29.6	31.1	33.0
21	16.9	19.7	21.3	22.5	24.6	26.0	27.7	29.3	31.1
22	15.5	18.3	19.7	20.9	22.9	24.2	25.9	27.4	29.2
23	14.3	16.9	18.3	19.4	21.3	22.6	24.3	25.8	27.4
24	13.1	15.6	16.9	18.0	19.8	21.1	22.7	24.1	25.8
25	12.0	14.4	15.7	16.7	18.4	19.6	21.2	22.7	24.2

* B. F.: Back-scatter factor.

TABLE III: PRIMARY AND SCATTERED RADIATION CONTRIBUTIONS TO THE DEPTH DOSE: 2 MEV VAN DE GRAAFF X-RAY GENERATOR
(h.v.l. 12.5 mm. Cu or 7.5 mm. Pb. T.S.D. 100 cm.)

Depth (cm.)	Primary Radiation	Scattered Radiation							
		Field Area (sq. cm.)							
		20	35	50	80	100	150	200	400
		Diameter of circular field (cm.)							
		5.05	6.68	7.98	10.1	11.3	13.8	16.0	22.6
0.3-0.4	100.0	1.8	2.5	3.0	3.7	4.0	4.6	4.9	5.6
1	94.0	4.0	5.4	6.0	6.9	7.2	8.1	8.9	9.5
2	86.4	5.7	7.8	8.9	10.1	10.6	11.8	12.5	13.6
3	79.5	6.5	8.8	10.3	12.1	12.8	14.3	14.9	16.1
4	72.8	6.8	9.2	11.0	13.2	14.0	15.6	16.5	17.5
5	66.9	6.7	9.4	11.4	13.6	14.7	16.4	17.7	18.6
6	61.3	6.6	9.2	11.4	14.1	14.9	16.6	18.2	19.7
7	56.2	6.4	8.8	11.2	14.0	15.2	17.2	18.9	20.4
8	51.6	6.1	8.5	10.7	13.9	15.4	17.4	19.1	20.9
9	47.5	5.8	8.1	10.2	13.5	15.1	17.5	19.1	21.0
10	43.5	5.6	7.9	10.0	13.2	15.0	17.3	19.1	21.3
11	39.9	5.3	7.5	9.6	12.8	14.8	16.9	18.6	21.2
12	36.6	5.0	7.3	9.3	12.4	14.4	16.4	18.3	20.6
13	33.6	4.8	7.0	8.9	12.0	13.9	16.1	17.9	20.4
14	30.9	4.5	6.7	8.5	11.6	13.3	15.5	17.5	19.8
15	28.2	4.3	6.5	8.3	11.2	13.1	15.2	17.0	19.3
16	26.0	4.0	6.3	8.0	10.6	12.4	14.7	16.6	18.6
17	23.9	3.9	5.8	7.4	10.2	11.9	14.0	15.9	18.2
18	21.9	3.7	5.7	7.2	9.8	11.4	13.6	15.4	17.5
19	20.1	3.5	5.3	6.9	9.3	11.0	13.1	14.8	17.0
20	18.5	3.3	5.1	6.5	9.0	10.5	12.5	14.1	16.4
21	16.9	3.2	4.9	6.3	8.6	10.1	12.1	13.8	16.0
22	15.5	3.1	4.7	6.0	8.2	9.7	11.6	13.2	15.3
23	14.3	2.9	4.5	5.7	7.8	9.2	11.1	12.9	14.6
24	13.1	2.8	4.2	5.4	7.4	8.9	10.6	12.2	14.1
25	12.0	2.6	4.1	5.2	7.1	8.4	10.2	11.8	13.6

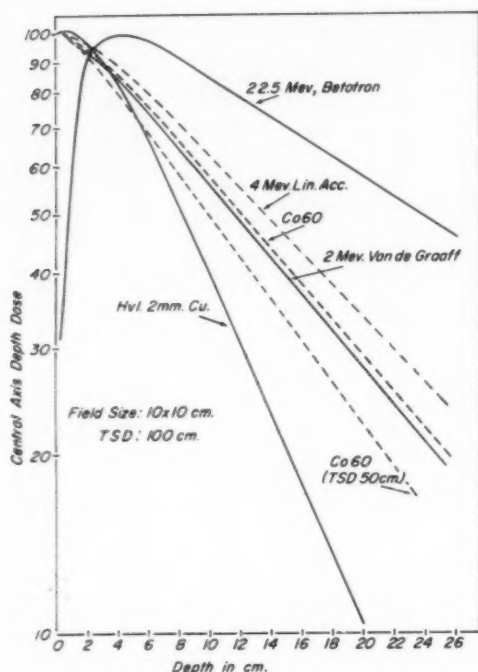


Fig. 8. Comparison of central axis depth doses of different qualities of x-rays.

date. The back-scatter factor for the cobalt unit, which we measured closely, confirmed the findings of Dixon *et al.* (3) and we have taken their data for our use. The back-scatter factors at different field sizes for the Van de Graaff generator are included in the central-axis depth-dose tables (Tables II and III). These factors at h.v.l. 12.5 mm. Cu are just slightly higher than those of the cobalt unit.

The Depth Dose with Fixed Target-Surface Distance: The difference between the central-axis depth doses of radiation produced by the 2-MEV Van de Graaff x-ray generator and the cobalt unit at the same target-surface distance is small. The depth dose of the Van de Graaff is only slightly less than that of the cobalt unit, which is shown in Figure 8. As the treatment distance for the Van de Graaff generator used is 100 cm. and the distance for the cobalt unit is 50 to 60 cm., the depth dose for the Van de Graaff is higher than the depth dose

for the cobalt unit due simply to the difference in treatment distances. Comparison of the central-axis depth dose for radiation of other energies, such as h.v.l. 2 mm. Cu, the 4-MEV linear accelerator, and the 22.5-MEV betatron, are also included in Figure 8. All the data shown in that figure are for a field size of 100 sq. cm. at T.S.D. 100 cm., with the exception of one cobalt curve at T.S.D. 50 cm. The difference of the depth dose between the 4-MEV linear accelerator and the 2-MEV energy range radiation is appreciable, but it does not result in big differences in planning the treatment. This, however, would not be true for radiation at betatron energy 22.5 MEV, which gives a much higher percentage depth dose.

The central-axis depth doses of the 2-MEV Van de Graaff generator published by Miller *et al.* at Sheffield (15) and Wheatley *et al.* at Royal Marsden Hospital (28) are based on taking the dose at 1 cm. depth as 100 per cent. The reason for this they stated to be convenience of measurement. The depth-dose tables published by Wilson and Perry at Westminster Hospital (29) are normalized at the maximum dose 4 mm. below the surface. It is beyond the scope of this paper to discuss the best reference point for depth-dose measurements, either at the maximum dose, the dose at 1 cm. under the surface, or even at 10 cm. below the surface. Our measurements of depth doses are normalized at the maximum dose.

The results of depth-dose measurements for the 2-MEV Van de Graaff generator at different depth and field areas at T.S.D. 100 cm., are presented in a series of curves (Fig. 9). The depth doses at zero field area are extrapolated from these curves with adjustments according to the data interpolated from the depth doses for zero field area for h.v.l. 10 mm., 12 mm., and 15 mm. Cu, as published in the *British Journal of Radiology*, Supplement No. 5 (2).

The central-axis depth doses are also presented in tabular form here, in Tables II and III. The scatter contributions at different field areas to the depth doses

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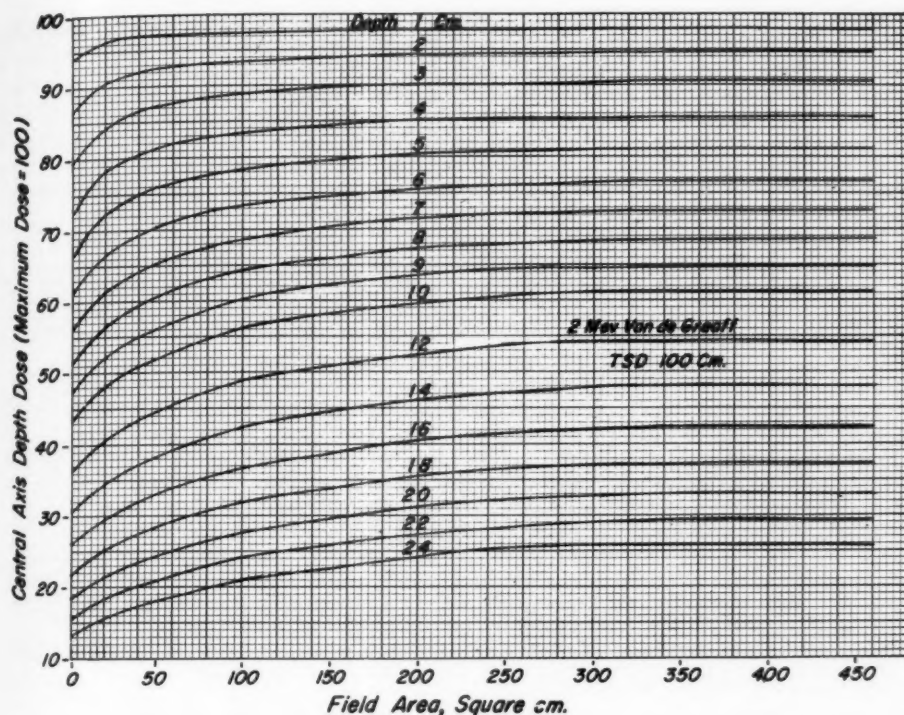


Fig. 9. Variations of central axis depth doses with depth and field area at T.S.D. 100 cm. for the Van de Graaff x-ray generator.

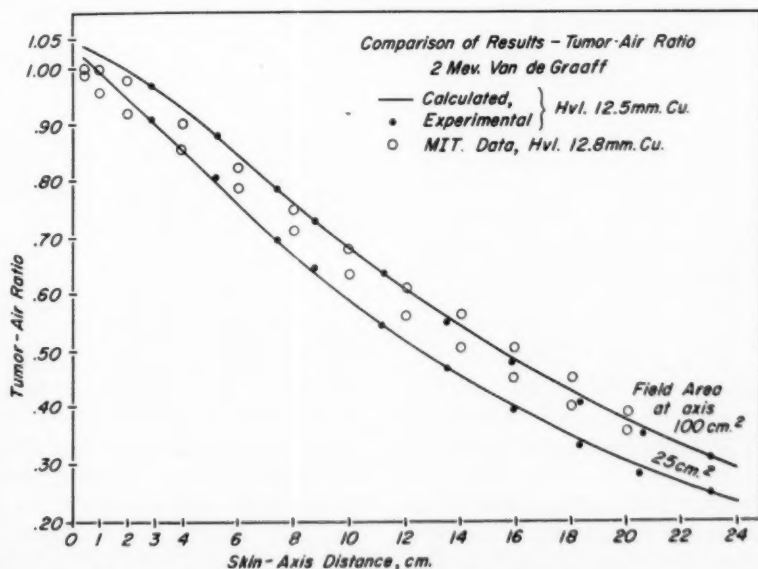


Fig. 10. Comparison of tumor-air ratios for the Van de Graaff x-ray generator obtained by calculation and by measurement, field size 10 × 10 cm. and 5 × 5 cm.

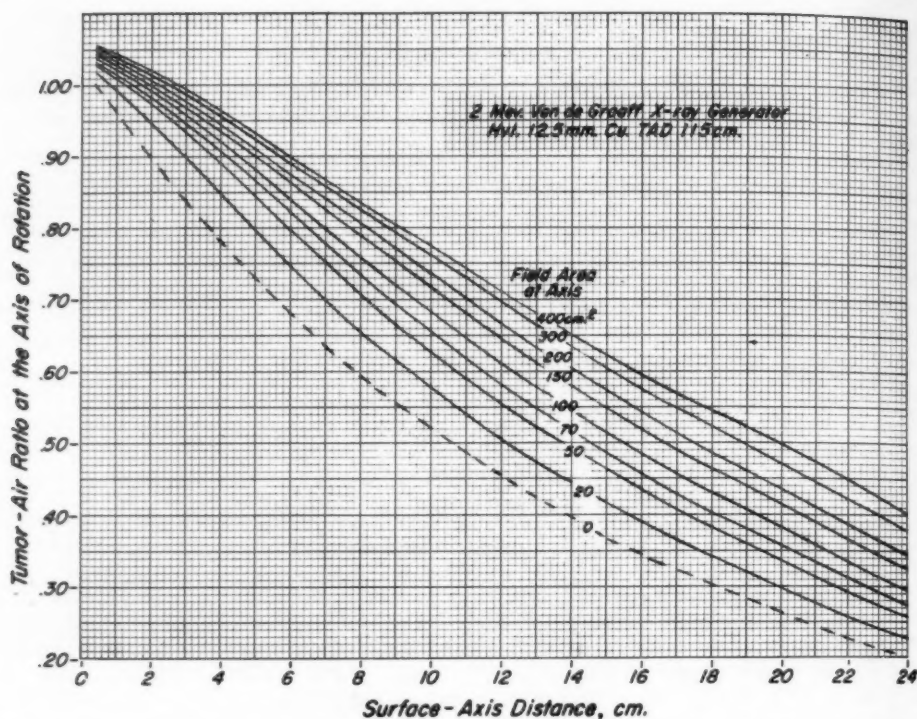


Fig. 11. Variations of tumor-air ratio with thickness of overlapping tissue at different field areas for the Van de Graaff x-ray generator.

TABLE IV: TUMOR-AIR RATIOS FOR 2-MEV VAN DE GRAAFF X-RAY GENERATOR
(h.v.l. 12.5 mm. Cu. T.A.D. 115 cm.)

Surface-axis Distance (cm.)	Field Area (sq. cm.)								
	0	20	50	70	100	150	200	300	400
6	0.680	0.748	0.798	0.822	0.840	0.860	0.872	0.890	0.897
7	0.635	0.699	0.751	0.776	0.796	0.825	0.841	0.860	0.866
8	0.594	0.653	0.707	0.735	0.760	0.790	0.805	0.823	0.835
9	0.556	0.615	0.663	0.691	0.718	0.751	0.770	0.793	0.801
10	0.522	0.578	0.629	0.656	0.684	0.716	0.737	0.767	0.776
11	0.486	0.539	0.590	0.616	0.645	0.682	0.700	0.730	0.745
12	0.454	0.504	0.552	0.580	0.610	0.645	0.664	0.694	0.710
14	0.398	0.445	0.491	0.518	0.546	0.580	0.605	0.638	0.650
16	0.346	0.390	0.435	0.456	0.481	0.516	0.541	0.573	0.591
18	0.302	0.342	0.382	0.401	0.430	0.461	0.486	0.521	0.541
20	0.264	0.300	0.337	0.357	0.383	0.415	0.435	0.470	0.497
22	0.228	0.256	0.294	0.311	0.333	0.366	0.387	0.421	0.449
24	0.190	0.226	0.257	0.273	0.295	0.324	0.348	0.380	0.400

(Table III) are calculated from the data in Table II.

The central-axis depth doses for the cobalt unit are found to follow closely the results published by Johns (11) and need not be repeated here.

The Depth Dose with Fixed Target-Chamber Distance: The depth doses measured for varying thicknesses of the absorbing material, with the distance from the target to the measuring point kept constant at 115 cm., follow closely the results obtained by

inverse-square calculation for the Van de Graaff generator. Calculations were based on the depth-dose table at T.S.D. 100 cm., with the correction by F factors for the changing of target-surface distance. The results obtained by calculation and by measurement for field sizes 10×10 cm. and 5×5 cm. are shown in Figure 10.

The dose values published by the Massachusetts Institute of Technology group (26) to be used in rotation for field areas 10×10 cm. and 5×5 cm., h.v.l. 12.8 mm. Cu,

TABLE V: PRIMARY RADIATION AND MEREDITH AND NEARY'S CONSTANTS: 2 MEV VAN DE GRAAFF X-RAY GENERATOR
(h.v.l. 12.5 mm. Cu. T.S.D. 100 cm.)

Depth (cm.)	Primary Radiation P	Meredith & Neary's Constants M	λ ($\frac{r+d}{r}$)
0.4	100.0	6.1	0.310
1	94.0	10.0	0.355
2	86.4	14.2	0.376
3	79.5	16.7	0.395
4	72.8	18.1	0.401
5	66.9	19.5	0.387
6	61.3	20.8	0.355
7	56.2	21.6	0.340
8	51.6	22.1	0.326
9	47.5	22.8	0.315
10	43.5	23.3	0.305
11	39.9	23.2	0.295
12	36.6	23.0	0.290
13	33.6	22.8	0.283
14	30.9	22.3	0.278
15	28.2	21.8	0.274
16	26.0	21.2	0.268
17	23.9	21.0	0.265
18	21.9	20.4	0.260
19	20.1	19.8	0.253
20	18.5	19.3	0.247
21	16.9	18.8	0.243
22	15.5	18.3	0.240
23	14.3	17.4	0.238
24	13.1	16.8	0.235
25	12.0	16.4	0.232

are also indicated in Figure 10. Their data for 5×5 -cm. field areas are expressed in terms of per cent of axis equilibrium dose determined for the 10×10 -cm. field, and it seems also that the back-scatter factors were neglected in these data.

The depth doses, in terms of air exposure dose = 100 per cent at the reference point at 115 cm. from the target, for other field areas are presented in Table IV and Figure 11. These data should be appli-

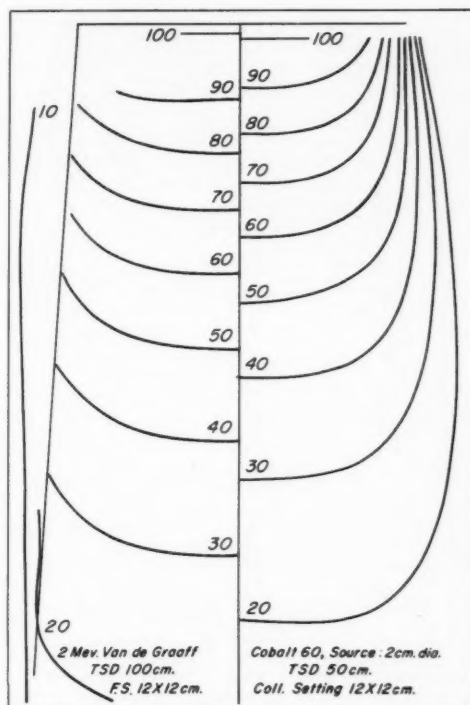


Fig. 12. Comparison between isodose curves at field size 12×12 cm. of the cobalt unit, T.S.D. 50 cm., and of the Van de Graaff x-ray generator, T.S.D. 100 cm.

cable to other target-axis distances without much error (12).

The tumor-air ratios for the cobalt unit have been published by Johns *et al.* (12). In our measurements, only some deviations from Johns' data were found for depths of tissue over 10 cm. These differences could be explained by the fact that the exposure dose rate of our cobalt unit does not strictly follow the inverse square law (see p. 490).

ISODOSE CURVES

Isodose curves for both the cobalt unit and the Van de Graaff generator were measured in a water phantom with a Fedoruk and Johns chamber (5). The scanning mechanism in our isotope laboratory was used for the remote control of the position of the chamber in the phantom and for recording the position whenever desired.

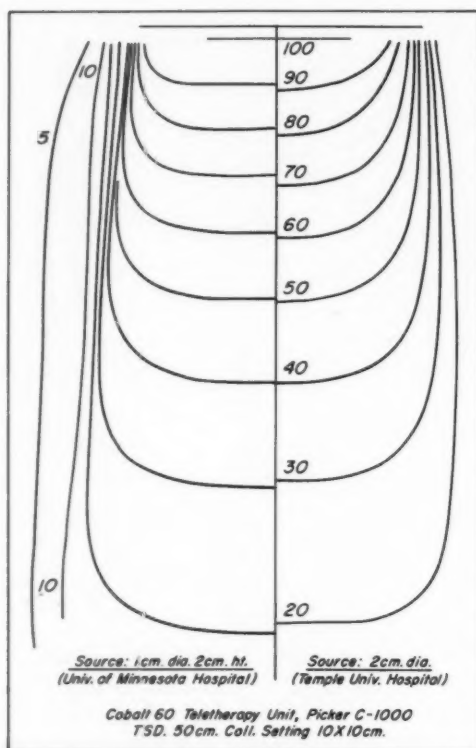


Fig. 13. Comparison between isodose curves at field size 10×10 cm. of the cobalt unit, T.S.D. 50 cm., with source 2 cm. in diameter and with source 1 cm. in diameter.

A number of isodose curves at different collimator settings for T.S.D. 50 cm. and 60 cm. for the cobalt unit and T.S.D. 100 cm. for the Van de Graaff generator were measured. Figure 12 shows, for comparison, the isodose curves of the cobalt unit, T.S.D. 50 cm., and of the 2-MEV Van de Graaff generator, T.S.D. 100 cm., at the same field size, 12×12 cm. The curves for the Van de Graaff generator indicate that the beam is apparently well defined. Figure 13 shows isodose curves for the cobalt unit with a 2-cm. diameter source and the cobalt unit with 1-cm. source, both at field size 10×10 cm., T.S.D. 50 cm. The differences between these two isodose curves are prominent near the surface of 90 per cent and 80 per cent curves.

The isodose curves for the 2-MEV Van de Graaff generator also have been calcu-

lated on the basis of the central-axis depth dose data. The method of calculation is based mainly on Meredith and Neary's basic equations, with the use of our digital computer. Details of these calculations have been published elsewhere (14, 17). The calculated values of the constants M and $\lambda \left(\frac{f+d}{f} \right)$ together with the primary radiation, P , are listed in Table V. Figure 14 shows the isodose curves at a field size 12×12 cm. for the 2-MEV Van de Graaff gen-

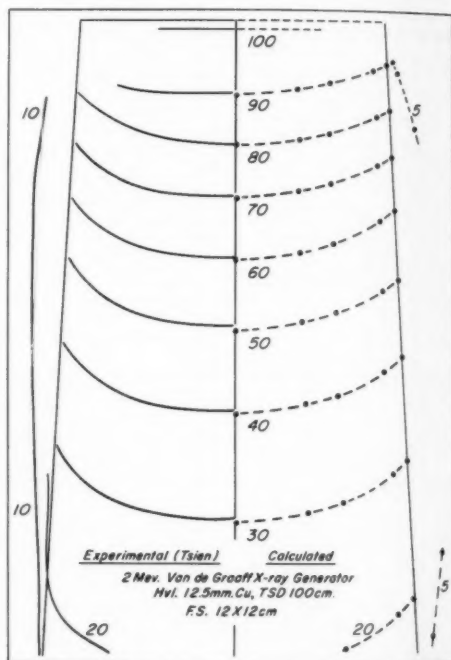


Fig. 14. Comparison between isodose curves at field size 12×12 cm., T.S.D. 100 cm., of the Van de Graaff x-ray generator by calculation and by measurement.

erator obtained by calculation and by measurements. The calculated curves are just slightly flatter than the experimentally obtained curves, especially near the edge of the beam; also, more scattered radiation appears outside the beam in the experimental curves than the calculated ones. This is probably due to the fact that some radiation is transmitted obliquely through the lower part of the beam-defining lead blocks.

TABLE VI: INDICATIONS OF INCREASING SURFACE IONIZATION BY ADDING COVERING MATERIALS ON THE IRRADIATED REGION

Material	Cobalt 60	2 MEV Van de Graaff
Maximum dose, 4 mm. Lucite plate	100%	100%
Adhesive tape with one 4 X 4 gauze plus one layer of sheet	87%	89%
Adhesive tape with two 4 X 4 gauzes	85%	88%
Adhesive tape with one 4 X 4 gauze	83%	86%
Adhesive tape only	78%	84%
Sheet only	78%	82%

SURFACE IONIZATION EFFECTS RESULTING FROM COVERING MATERIALS APPLIED TO THE IRRADIATED REGION

The fact that with supervoltage radiation the maximum ionization occurs at a greater depth below the surface as the voltage is increased was demonstrated as early as 1943 by Trump and Cloud (22) and was designated by them the "subcutaneous effect." The region between the surface and maximum ionization depth has been recognized as the "build-up" region. The ratio of the maximum response to the response with a very thin-front-wall chamber is now called the build-up ratio. This effect for cobalt-60 radiation and x-rays from the Van de Graaff generator has been investigated and published by a number of authors, as for instance Trump *et al.* (22, 23), Howarth (7, 8), Johns (11), Richardson *et al.* (18), etc.

Because of the build-up effect, it is obvious that, if there are any covering materials over the skin during irradiation, the skin will receive considerably more radiation than when it is not covered. In practice, it often occurs that the treated region is covered with materials, such as sheets, adhesive tape, and surgical gauze. Measurements of their effects were made with an ionization chamber with back-scatter by covering the chamber with those materials. The results are given in Table VI and are expressed in terms of percentages of the maximum dose. It shows that the more covering materials on the skin, the larger the dose received on the skin surface.

ACKNOWLEDGMENTS: Acknowledgment is made to The Cancer League of Philadelphia for the generous gift of the Picker C-1000 cobalt unit and to the Donner Foundation for the 2-MEV Van de Graaff X-ray Generator.

The isodose curves for the 1-cm. source cobalt unit, Figure 13, are reproduced by the kind permission of Dr. Donn G. Mosser, Director, Division of Radiation Therapy, University of Minnesota Hospitals.

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SUMMARY IN INTERLINGUA

Comparation De Un Machina Teletherapeutic A Cobalt⁶⁰ E Un Roentgeno-Generator Van De Graaff A 2 MEV, Basate Super Mesurationes Physic

Un machina teletherapeutic a 1.000 curies de cobalt⁶⁰ con un fonte de 2 cm e un roentgenogenerator Van de Graaff a 2 MEV esseva installate al Departamento de Radiologia del Centro Medical del Universitate Temple a Philadelphia durante le ultime parte del anno 1956 e le comenciamento del anno 1957. Ante le utilisation del machinas in programmas therapeutic, extense mesurationes physic pro usos clinic esseva effectuate.

Le duo machinas es del mesme ordine de energia, sed illos differe non solamente in lor construction e le modo de lor operation sed etiam in certes del characteristics del fascies que illos produce. Le mesurationes esseva facite principalmente in tres phases. Primo, un investigation esseva facite de omne le pertinente factores que affice le valor exposition-dosage in aere, i.e., distantia, dimension de campo, corrente fascial, e voltage (le ultime duo solamente) in le caso del generator Van de Graaff. Secundo, esseva determinate le triple relationes de dose in profundor, di-

mension de campo, e profundor in un histoequivalente mixtura cerose "D" o in un phantoma de aqua. Esseva includite in iste parte del investigation mesurationes de factores de retrodispersion e de curvas isodosal. Esseva etiam determinate le distribution de dosage in le plano perpendicular al axe fascial al profundor del dose maximal. Le areas coperite per le lineas isodosal in iste plano a differente adjustmentes del collimator monstra le effectos del penumbra e provide un definite signification del dimensiones de campo in le machina a cobalt. In le tertie parte del investigation, le calculate proportiones de dosage tumori-aeree in therapia de rotation esseva verificate per mesurationes. Le emission secundari de electrones ab objectos proxime al superficie irradiate esseva investigate. Esseva etiam mesurate factores contributori al dose cutanee como resultado del materiales in uso commun pro coperir le patientes; i.e., pannos de lino, banda adhesive, gaza chirurgic, etc.

DISCUSSION

James C. Katterjohn, M.D. (Indianapolis, Ind.): Are we to interpret Dr. Tsien's last slide (Table VI) to mean that if the patient is covered with a sheet the surface dose is increased to 78 per cent?

Mr. Tsien: The actual surface dose is difficult to determine. There are a number of factors which affect the actual value. According to published data for cobalt, the surface dose without any covering materials may be as low as 30 to 40 per cent of the maximum dose. Table VI shows the effect of different covering materials expressed in terms of percentage of maximum dose; it is seen that the less covering material used the less is the effect on the surface ionization received.

E. W. Webster, Ph.D. (Boston, Mass.): I would like to congratulate the authors on carrying through a great deal of careful work and presenting such a compendium of information about these two machines. Users of this equipment should be most grateful to them for their industry.

As the authors have noted there have already been a large number of physical measurements made on both the Van de Graaff machine and on the cobalt units. Perhaps the main justification for this paper is the presentation in one place of this fairly well established data side by side. My justification for discussing it is that I represent one of the relatively few institutions which is also lucky enough to have both modalities in everyday use.

It is clear that the Van de Graaff machine has physical properties somewhat superior to those of the normally available cobalt unit. The superiority is illustrated rather academically by the observation that reproduction of the physical performance of the Van de Graaff machine would require more than 4,000 curies of cobalt 60 and, more important, the specific activity would have to approach the impossible figure of 2,000 curies per gram. Today you are lucky if you get 50 curies per gram. A cobalt machine is designed to minimize its inherent disadvantages. One important omission in this paper is a discussion of the superior qualities of the Van de Graaff machine in terms of higher output and capacity to give a much more highly defined beam.

A comparison of machines on the basis of physical measurements is somewhat academic. It really requires a careful radiation therapist, not a physicist, to evaluate the clinical importance of the physical advantages, and disadvantages. I suspect that they are not of major significance. After this evaluation, the interesting paper which should be written is how do these relatively similar high-energy devices—and I mean here the Van de Graaff, cobalt 60, the resonant transformer, the linear accelerator, and the betatron—compare economically relative to

their specific advantages. In other words, the final comparison should have a price tag on it.

There are several things that the authors have discussed which we have also noted, and which I would like to emphasize. The first is the variation of dose-rate with field area. This is significant, particularly when combined with variations of back-scatter factor. We have found, in drawing up tables of depth dose based on the exposure dose rate with a 10 × 10 field, that the skin dose for small fields is almost 10 per cent less than for a 10 × 10 field. Half this difference is due to change of air dose and half due to the reduced back-scatter. This is true for both cobalt and the Van de Graaff machine. I agree with the authors that the back-scatter is significant enough to include in dose calculations.

Second, is the question of field size specification: I agree with the authors that this should not be arbitrary. It can be very misleading to quote field size based on the position of the 50 per cent isodose curves, especially when the penumbra is large. Many therapists do not realize that a light localizer which uses a small light source will indicate the beam edges as half way across the penumbra. This may mean, in many cobalt units, that an 8 × 8-cm. indicated field is in fact reasonably uniform over only a 6 × 6-cm. area. It should be relatively easy to calibrate the field size control knobs so as to indicate the distance between the 90 per cent isodose lines, or perhaps the geometric edges of the useful beam without penumbra.

Third, is the question of field definition with the Van de Graaff machine. Here is an excellent example of how the collimation geometry affects the penumbra. We have a focal spot of average dimension about 4 mm., which seems very small; but the penumbra measured at 125 cm. away, with the normal beam-defining blocks, is almost 1.5 cm., which is about the same as our cobalt unit gives (with a 15-mm. diameter source). Of course, the beauty of the Van de Graaff machine is that this penumbra can be reduced to 4 or 5 mm. by adding external collimation.

Finally, two specific points. How do these depth dose data agree with those in Supplement No. 5 of the *British Journal of Radiology* when suitably interpolated for 12.5 mm. Cu? I do not see how the surface ionization measurements can have much meaning unless the true surface dose (measured with a very thin-walled flat chamber) is compared with the dose under the various coverings. Perhaps, also, the field size and diaphragm distance in these comparisons could be specified, since the surface dose will vary with these parameters.

Mr. Tsien (closing): Answering Dr. Webster's question: From the central axis depth dose data for h.v.l. 15, 12, and 10 mm. Cu given in the *British Journal of Radiology*, Supplement No. 5, I

have interpolated the data for h.v.l. 12.5 cm. Cu at zero field size, and adjusted these with the data extrapolated from our curves. These are the data used for the zero field size depth doses in our Tables II and III for the 2-MEV Van de Graaff generator. Our data for other field sizes have been checked with depth doses published by Wilson and Perry of Westminster Hospital. It seems to me that their values are a little lower; for example their values of some depth doses for 4×4 cm. fields are smaller than the

interpolated values for zero field size from the *British Journal of Radiology* Supplement.

I quite agree with Dr. Webster's view that the true surface dose should be measured. Much work has been done on such measurements by other workers. In our discussion on surface dose, we are mainly interested to illustrate the fact that it is highly recommendable to remove all covering materials during treatment with cobalt or 2 MEV Van de Graaff x-rays.



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Transit-Dose Measurements in Cobalt-60 Rotation Therapy Dosimetry¹

PAUL M. PFALZNER, M.Sc.²

IN RECENT YEARS there has been a growing interest in all forms of rotational or moving-field therapy, and many different types of therapy machines designed for this kind of treatment have become available. To the medical radiation physicist, the dosimetry of rotation therapy has presented a number of interesting problems, and much useful work has been published on the basic data of dose distribution and dosage calculation. All of the currently popular methods of dose determination—except direct measurement on the patient, which, for good reasons is rarely popular—assume that the absorbing medium is homogeneous and water-equivalent. For many purposes, this may be adequate, but for irradiation of certain parts of the human body, such as the pelvis or the thorax, it is quite apparent that this assumption breaks down badly, especially at conventional x-ray energies. Even with cobalt-60 radiation, discrepancies of 20 to 30 per cent between calculated and measured doses are found in irradiating such heterogeneous tissues. It therefore becomes imperative to be able to assess the magnitude of such discrepancies in some simple fashion.

I propose to deal here with this particular aspect of rotation dosimetry. I shall describe our attempts to work out a reasonably simple method which takes account of the inhomogeneities of the medium.

At the London Clinic of the Ontario Cancer Foundation we have been using rotation therapy with the Eldorado Cobalt-60 Unit since early 1955. At the outset we decided to adopt the concept of the "tumour-air ratio" (as described by H. E. Johns *et al.*) as the basis of our rotation dosimetry.

The ratio is defined as follows:

$$R_c = \frac{D_c}{D_{ca}} = \frac{F^2}{(F-t)^2} (B) \frac{P}{100}$$

where

- D_c = the dose rate at the tumour (centre of rotation)
- D_{ca} = the dose rate in air at the centre of rotation
- F = the distance of source to centre of rotation
- t = the thickness of absorber between source and centre of rotation
- B = the back-scatter factor for the field size and energy in question
- $P/100$ = percentage depth dose at depth t

From graphs of R_c versus t , with field size as parameter, one obtains all the necessary information to determine the dose at the centre of rotation; for cobalt-60 therapy irradiation this is often sufficient on the basis of known dose distributions and their lack of sensitivity to changes in the shape and size of the absorber. This holds strictly only for water-equivalent tissue.

Our approach to the problem of correcting what may be called the crude tumour-air ratio values for the effects of non-water-equivalent tissues is based on the use of transit-dose values. Our original method, which is now superseded to some extent by simplifications which I shall discuss presently, has been described in *Acta Radiologica*, January 1956. Briefly, a dose-rate chamber is placed in the centre of the beam emerging from the patient and some distance away from the exit surface (with suitable precautions against registering scattered radiation) and the primary transmitted dose-rate is measured for every ten degrees (or other small interval) of rotation. The ratio of this dose-

¹ Presented as part of a Symposium on Cobalt-60 Therapy at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

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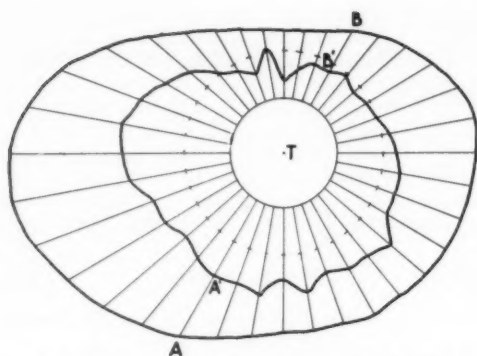


Fig. 1. Outline of patient's chest; centre of rotation at T; radii drawn at ten-degree intervals; water-equivalent outline (inner irregular curve) obtained from transmission ratios.

rate to that at the same point in air with no absorbing tissue in the path of radiation, is a measure of the transmission of the medium, and may be called the "transmission ratio," ΔT . This ratio is now used to calculate an equivalent thickness of homogeneous water-equivalent absorber. That is,

$$\Delta T = \frac{D_t}{D_0} = e^{-\mu d_e}$$

where

- D_t = the transmitted dose rate
- D_0 = the air dose rate at the same point
- μ = the linear absorption coefficient for primary radiation in water
- d_e = the equivalent absorber thickness

Using the values of equivalent thickness, d_e , one can construct an "equivalent outline" (Fig. 1) for the patient in question and for the particular conditions of irradiation, where equivalent outline is defined as the size and shape of water-equivalent absorber which gives the same transmission ratios as the actual patient. The usual method of dosage calculation is then applied to this outline, that is, the tumour-air ratios for every ten degrees, say, corresponding to the equivalent radial distances, are obtained from graphs, the final value being the average of these. The tumour dose rate is then found by multiplying the average tumour-air ratio with the output in r per minute in air at the centre of rotation.

In the paper referred to above, it was

shown that this method is valid, especially for cobalt-60 radiation.

A simpler approach may be derived from a study of Figure 2, which shows tumour-air ratios for x-rays of h.v.l. 1.0,

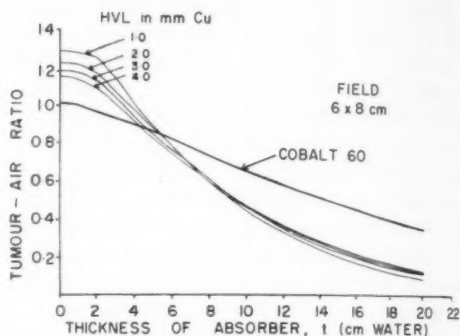


Fig. 2. Tumour-air ratio values versus thickness of absorber for h.v.l. of 1.0, 2.0, 3.0, and 4.0 mm. Cu and Cobalt 60, for field size of 6 x 8 cm.

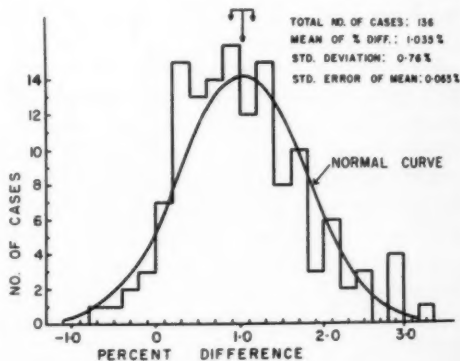


Fig. 3. Frequency distribution of the difference between R_t and $R_e(l)$ as percentage of R_e for series of 136 patients. Mean of per cent differences = 1.035 ± 0.130 (95 per cent confidence).

2.0, 3.0, and 4.0 mm. Cu and for cobalt 60 plotted against depth of absorber. The x-ray curves, all quite closely bunched, are seen to have a fairly steep slope at first, flattening out at greater depths; the tumour-air ratio curve for cobalt 60, however, begins to approach a straight line. We suspected that this approximate linearity is sufficiently close for clinical purposes to allow of a further and extremely convenient simplification in our procedure. We therefore set out to compare

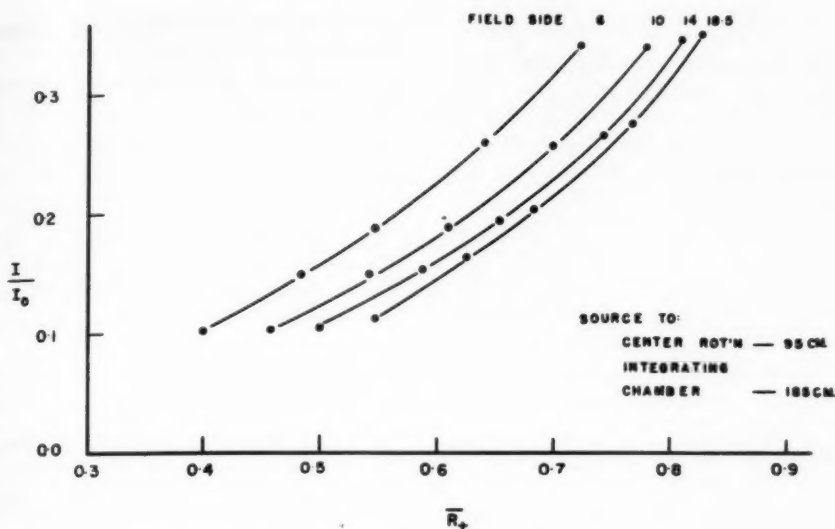


Fig. 4. Transmission ratio versus tumour-air ratio for Cobalt 60.

$$\bar{R}_c = \frac{1}{n} [R_c(t_1) + R_c(t_2) + \dots R_c(t_n)]$$

with $R_c(\bar{l})$, where $\bar{l} = 1/n (t_1 + t_2 + \dots t_n)$; that is, we were interested in seeing whether, instead of taking tumour-air ratios for each radial distance and then averaging, one could simply first find the average radial distance, and then use a single corresponding value of the tumour-air ratio.

In order to test this idea, we surveyed a series of 136 patients treated by rotation therapy, for whom the standard or crude tumour-air ratio calculations had been made. Our 136 cases included sites in the head, neck, and upper and lower trunk, i.e., all those treated by rotation therapy (partial or full 360°) since 1954 both at the Windsor Clinic, with the Cobalt Theratron, and at the London Clinic, with the Cobalt Eldorado Unit. It must be said that, owing to the first flush of enthusiasm for rotation therapy, the series includes many cases where the axis of rotation is so eccentrically situated that we would now perhaps not rotate at all. The results, however, show that it is perfectly safe to use an average radius, when treating with cobalt 60, in all these cases. Statistical

evaluation of the frequency distribution (Fig. 3) shows that the mean difference between \bar{R}_c and $R_c(\bar{l})$ is +1.035 per cent with a standard deviation of the mean of 0.755 per cent, and a standard error of the mean of 0.065 per cent. The t value is 16; thus, the value of 1.035 per cent for the mean is exceedingly significant (to put it mildly), a result due to the slight curvature of the cobalt-60 tumour-air ratio curves.

This means that, using an average radius \bar{l} to obtain the single value of the tumour-air ratio $R_c(\bar{l})$, and applying a 1 per cent correction to this value, one will, with 95 per cent probability, be within 1.5 per cent of \bar{R}_c , the tumour-air ratio based on individual radii.

We can now see how this result can be extended to our work on transmission ratios. We could similarly reduce the equivalent patient outline (Fig. 1) to a circle by averaging the equivalent radial distances. It is more convenient, however, as well as accurate, to integrate the transit dose over a complete rotation cycle (with an integrating dose chamber in place of a dose-rate meter) and then to calculate, from the integrated transmission ratio, T , an average equivalent radius, \bar{l} . That is

$$T = \int_0^\theta D_t d\theta / D_0 \tau = e^{-2\mu\bar{r}\theta}$$

where τ is the period of one rotation cycle.

Alternatively, one can read the corresponding tumour-air ratio $R_c(\bar{r}\theta)$ directly from a family of graphs of transmission ratio versus tumour-air ratio (Fig. 4) with field size as parameter.

It will be seen that the method is accurate, relatively simple, and rapid. It is inherently more accurate than the method of summation since, in addition to taking account of changes in absorption due to tissue inhomogeneities, it deals not with discrete radial distances but with continuously varying values.

Summing up, we see that for all body sites where one may take the irradiated tissues to be water-equivalent, the average body radius may be used to calculate tumour dose in cobalt-60 rotation therapy. Wherever the tissues depart markedly

from water-equivalence, the integrated transmission ratio enables one to reduce the irradiated medium to a water-equivalent one.

ACKNOWLEDGMENT: The data on the series of 136 rotation patients were made available through the kindness of Dr. Ivan H. Smith, Director of the London Clinic, and Dr. Norman A. McCormick, Director of the Windsor Clinic of the Ontario Cancer Foundation. The work was supported by a grant from the Ontario Cancer Treatment and Research Foundation.

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SUMMARY IN INTERLINGUA

Mesurationes De Dosage De Transito In Dosimetria De Therapia Rotational A Cobalt⁶⁰

Al Clinica London (Ontario), le calculation del dosage in therapia rotational a cobalt⁶⁰ es basate super le concepto del "proportion tumori-aeree." Pro omne sites del corpore ubi le histos irradiate pote esser considerate como equivalente a aqua, le radius medie del corpore pote esser usate pro le calculation del dose al tumor. Pro histos que devia significativamente ab le equivalentia con aqua, le si-appellate "crude" proportiones tumori-aeree pote esser corrigite per le uso del valores del

doses de transito. In le uso de cobalt⁶⁰ le linearitate del proportion tumori-aeree es tal que in loco de obtener le proportion tumori-aeree pro omne distantia radial individual e de prender ab isto le valor medie, il es permissibile integrar le dose de transito pro un complete cyclo de tractamento, i.e., le distantia radial medie pote esser determinate e un sol valor correspondente pro le proportion tumori-aeree pote esser usate.

DISCUSSION

Arnold Feldman (Denver, Colo.): Might it be practical for people who don't have the means of making transit-dose measurements to make an average correction for the part of the body being irradiated? That is, let us say, for the upper thorax, to make an arbitrary correction of 20 per cent for all patients. Is the mean of variation among patients too great for such an average to be used?

Paul M. Pfalzner: I think it is possible to use an average factor, but certainly you lose a lot of accuracy because it has been shown that there is quite an individual variation from patient to patient in this absorption. Some lungs seem to be more tenuous and some more absorbing than others,

and it does seem to me advisable to make an individual measurement.

Miss Lillian Jacobson (Newark, N. J.): We are not dealing with accuracies of less than 5 per cent. I think a fairly accurate correction can be made by the use of a correction factor which will depend on the location of the lesion, the direction of the radiation, and the number of ports. I can think of tumor locations in the chest where the correction might vary from 20 to 50 per cent and yet the transmission dose might be the same. I am not so sure that the transmission dose is a better indication of what the center of a tumor is receiving than the dose corrected by a correction factor.

Averaged Tumour-Air Ratios for 360-Degree Cobalt-60 Rotation Therapy¹

ROBERT H. HAYNES and GERD FROESE

THE DOSE OF RADIATION that is received at the centre of an irradiated tumour is widely used in radiotherapeutics to characterize the whole radiation field in which the tumour is immersed. This practice seems to be fairly well justified for 360° rotation radiotherapy, where most dose distributions are reasonably symmetrical. Johns, Whitmore, Watson, and Umberg (1) have worked out a system of rotation dosimetry that enables one to calculate the central tumor dose from the "averaged tumour-air ratio." Since these tumour-air ratios are obtained from measurements on water phantoms, this system of dosimetry is based on the assumption that tissue is water-equivalent. At the present time there is much interest in the so-called "transit-dose" methods of calculating the central tumour dose in order to eliminate, as far as possible, the error that is introduced by the water-equivalence assumption. There are many clinics, however, in which it is inconvenient to make routine transit-dose measurements, in which "water-equivalent" methods are still in use. Even in those cases in which transit-dose measurements are made, it is often desirable to use a water-equivalent method to make an initial estimate of the central tumour dose so that the treatment program can be started; the total dosage can be adjusted later when the transit-dose measurements have been obtained.

In a previous paper (2) the authors developed a simple water-equivalent method for calculating the average tumour-air ratio for 360° vertical rotation therapy. It was applied to a clinical series of 48 rotation cases treated with AECL cobalt-60 teletherapy units, and was found to

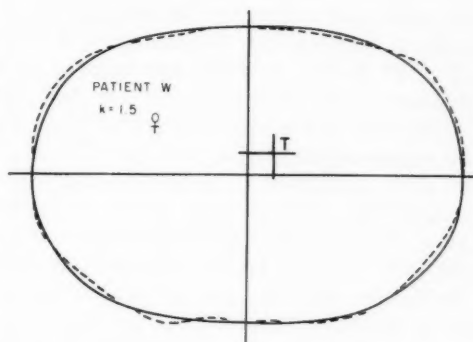


Fig. 1. Comparison of the idealized body contour (solid curve) with an actual thoracic contour of a patient (broken line).

yield results that showed no statistically significant difference from those obtained by the longer method of Johns *et al.* (1).

The original calculations of Haynes and Froese (2) were based on a set of tumour-air ratios obtained from the older depth-dose data and back-scatter values of Johns (3). However, Johns, Morrison, and Whitmore (4) have recently published a more complete set of tumour-air ratios for cobalt-60 radiation, which is valid for all source-tumour distances in the range of 40 to 100 cm. These new data form the basis of the calculations that are reported in this paper.

OUTLINE OF IDEALIZED BODY CONTOUR METHOD

In Figure 1 the body cross section of a typical patient in the treatment plane is indicated by the broken curve; the estimated tumour centre is at the point T. The problem of determining the central tumour dose when the treatment beam (or the patient) is rotated uniformly about this point involves the calculation of the

¹ From the Ontario Cancer Foundation, London Clinic (Ivan H. Smith, M.D., Director), Victoria Hospital, London, Ontario. Presented as part of a Symposium on Cobalt-60 Therapy at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

averaged tumour-air ratio at T, *i.e.*, the average of the tumour-air ratios corresponding to all tumour-skin distances around the contour. This averaged tumour-air ratio can be approximated by the method of Johns *et al.* (1) or by the idealized body contour method of Haynes and Froese (2). In Johns' method, the tumour-skin distances are measured every 10° or 20° around the contour; the set of tumour-air ratios corresponding to these distances is then averaged to give the averaged tumour-air ratio at the point T. The method of Haynes and Froese depends on the fact that practically all body contours that occur clinically can be approximated by a simple trigonometric function, the so-called "idealized body contour." The equation of the idealized body contour is given, in polar form, by

$$r = A - B \cos 2\theta \quad (1)$$

where the parameters A and B can be written in terms of the semi-major, a , and semi-minor, b , axes of the patient (one-half the lateral and anteroposterior dimensions, respectively) *viz.*,

$$\begin{aligned} A &= (a + b)/2 \\ B &= (a - b)/2 \end{aligned} \quad (2)$$

In Figure 1 the idealized body contour corresponding to the lateral and anteroposterior dimensions of the patient's contour is indicated by the solid curve. It can be seen that it is a good approximation of the actual contour, which is represented by the broken curve.

A simple method of finding the central dose for a tumour located at the centre of the body contour would consist in calculating the average of $r(\theta)$ around the contour in terms of a and b . The tumour-air ratio corresponding to this average radius, \bar{r} , could then be obtained from the data of Johns *et al.* (4), *i.e.*,

$$\begin{aligned} \bar{r} &= \frac{1}{2\pi} \int_0^{2\pi} r(\theta) d\theta = \\ &= \frac{1}{2\pi} \int_0^{2\pi} (A - B \cos 2\theta) d\theta = A = \frac{a + b}{2} \end{aligned} \quad (3)$$

Thus the average of the semi-major and the semi-minor axes of the patient, as obtained from direct measurement with calipers of the patient's anteroposterior and lateral dimensions, or from a contour diagram, gives at once the average radius for a centrally located tumour. It is then easy to find the corresponding tumour-air ratio.

Such a procedure presupposes that the tumour-air ratios are a linear function of the tissue thickness, r , over the range of r being used. However, this requirement is not fulfilled and the above-mentioned method will therefore be subject to some error. It has been previously pointed out by Johns *et al.* (4) that the discrepancy between using the tumour-air ratio corresponding to the average radius and averaging the tumour-air ratios corresponding to the individual radii is not large for cobalt-60 radiation but may be as high as 10 per cent for 200-kv x-rays. Pfalzner (5) has made a statistical analysis of the error involved in using the average radius on 136 cobalt-60 rotation cases. He found that the tumour-air ratio corresponding to the average radius was on the average 1.04 per cent too low as compared with the average of the corresponding tumour-air ratios. The standard deviation of this error was about 0.76 per cent and the maximum error about 3 per cent. Thus, the average radius method is not applicable when x-rays are used, and, even though the error is small for cobalt-60 radiation, there is no good reason for tolerating it.

To evaluate the average integral of the tumour-air ratio around the idealized body contour for a centrally located tumor, it is necessary to be able to write the tumour-air ratio, $R(r)$, as a function of the radius, r . It was found that over the range $2 \leq r \leq 20$ cm. the tumour-air ratio could be closely represented by the double exponential,

$$R(r) = A_1 e^{-\alpha_1 r} + A_2 e^{-\alpha_2 r} \quad (4)$$

A_1 , A_2 , α_1 , and α_2 are empirical constants which depend upon the energy of the radia-

tion and field size. The averaged tumour-air ratio for 360° rotation about a central tumour is then given by,

$$\bar{R} = \frac{2}{\pi} A_1 e^{-\alpha_1 A} \int_0^{\pi/2} e^{\alpha_1 B \cos 2\theta} d\theta + \frac{2}{\pi} A_2 e^{-\alpha_2 A} \int_0^{\pi/2} e^{\alpha_2 B \cos 2\theta} d\theta \quad (5)$$

The integrals in (5) can also be written in terms of zeroth order modified Bessel functions of the first kind, viz.,

$$\bar{R} = A_1 e^{-\alpha_1 A} I_0(\alpha_1 B) + A_2 e^{-\alpha_2 A} I_0(\alpha_2 B) \quad (6)$$

The function $I_0(z)$ is usually defined in terms of $\cos \theta$ rather than $\cos 2\theta$; however, a simple change of variables casts them into the form required by (5). The value of $I_0(z)$ on the range of values of $\alpha_1 B$ or $\alpha_2 B$ encountered clinically is only slightly greater than unity, which emphasizes the fact, noted in the authors' original paper (2), that the integrals in (5) can be considered to be only small correction factors in \bar{R} . The Equations (5) or (6) are best evaluated in series (unless a library routine is available for I_0) and written in terms of the parameters b and k (where $k = a/b$ is the axial ratio of the patient) as follows:

$$\bar{R}(b, k) = A_1 e^{-1/2 \alpha_1 b(k+1)} \left[1 + \frac{1}{16} \alpha_1^2 b^2 (k-1)^2 \right] + A_2 e^{-1/2 \alpha_2 b(k+1)} \left[1 + \frac{1}{16} \alpha_2^2 b^2 (k-1)^2 \right] \quad (7)$$

The expression for $\bar{R}(b, k)$ thus obtained enables the construction of tables or graphs of \bar{R} in terms of b and k , which provide a simple and rapid means of obtaining the averaged tumour-air ratio for a centrally located tumour.

The case of noncentral tumours can be handled by multiplying $\bar{R}(b, k)$ by an empirical eccentricity correction factor $C_e(r'/r)$; i.e., if the co-ordinates of the location of the tumour, T , are (r', θ') , then the value of \bar{R} at T (denoted by \bar{R}') is given by,

$$\bar{R}' = C_e \bar{R}(b, k) \quad (8)$$

where C_e is written as a function of the

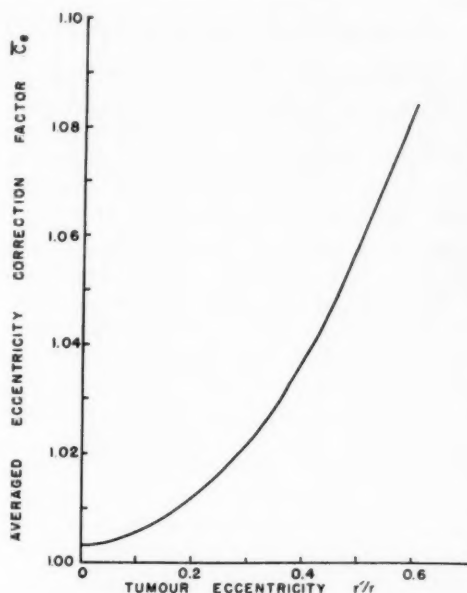


Fig. 2. Averaged eccentricity correction factor $C_e(r'/r)$. The curve does not pass through zero since a small difference was observed between the calculated and Johns' method for centrally located tumours.

ratio of the centre-tumour, r' , and centre-skin, r , distances.

The value of $C_e(r'/r)$ depends on the angular orientation of r' , the axial ratio k , the semi-minor axis b , and the field size. Of all of these parameters that affect $C_e(r'/r)$, only the semi-minor axis and the field size are of any importance; and even these become significant only for values of r'/r greater than 0.4. Inasmuch as there is virtually no physical advantage to be gained in rotating tumours through 360° that are located as far off-centre as this, it is sufficient to use the "averaged" eccentricity correction curve, $C_e(r'/r)$, that was described in the authors' previous paper (2). Furthermore, since the value of C_e is close to unity for $r'/r < 0.3$, and since the position of the majority of tumours for which 360° rotation would be the treatment of choice corresponds to a value of r'/r not much exceeding 0.3, this correction can often be neglected. The average eccentricity correction curve is reproduced in Figure 2.

CALCULATION OF TABLES OF $\bar{R}(b, k)$

The first step in the numerical evaluation of Equation (7) is to determine the empirical constants A_1 , A_2 , α_1 , and α_2 . For the values of $\bar{R}(b, k)$ which are presented in this paper, the constants were obtained from the tumour-air ratios recently published by Johns *et al.* (4). A logarithmic plot of the tumour-air ratios against the radius, r , results in a straight line except for small values of r . The intercept with the ordinate and slope of the line gives at once the constants A_1 , and α_1 , respectively. The deviations of the actual curve from the straight line were again plotted on semilogarithmic paper to obtain A_2 and α_2 . This process could be repeated for greater accuracy to obtain further constants for another exponential term. However, as has been pointed out earlier, two exponential terms (Equation (4)) were found to represent $R(r)$ closely over the range $2 \leq r \leq 20$ cm. The constants thus found for cobalt-60 radiation and 16 field sizes are presented in Table XVII.

Using these constants, the calculation of tables of $\bar{R}(b, k)$ for the clinically important range of b and k was carried out at the Computation Centre, University of Toronto, on the digital computer FERUT. Tables I-XVI appended to this paper are abbreviations of the complete tables obtained. They give values of $\bar{R}(b, k)$ for $k = 1.0, 1.1, \dots, 1.775$ and $b = 6, 7, \dots, 16$; intermediate values can be obtained by linear interpolation between the tabulated values. The tables can also be used to prepare graphs to avoid interpolation.

WORKED EXAMPLE

The curve in Figure 3 represents a typical body contour that might be encountered clinically; the estimated tumour centre is at T. Let us suppose that it has been decided to treat the patient by cobalt-60 rotation therapy, with a field size of 8×8 cm. The problem now is to find the average tumour-air ratio with the help of the tables presented in this paper.

The first step is to measure the antero-

posterior and lateral dimensions of the patient. These values can be determined from the contour diagram as shown in Figure 3. We note: $2a = 21$ cm., $a = 10.5$ cm., $2b = 14$ cm., $b = 7$ cm., and $k = 2a/2b = 1.5$. For a field of 8×8 cm. we now turn to Table XI and observe that for $b = 7$ and $k = 1.5$ the value of

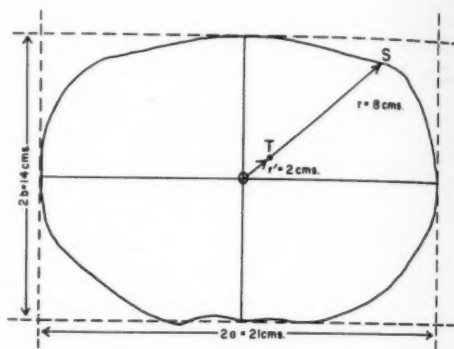


Fig. 3. Illustration of the worked example in the text.

$\bar{R}(b, k)$ is given as 0.721. To apply the eccentricity correction we measure r' and r (see Fig. 3), e.g., $r' = 2$ cm. and $r = 8$ cm. Therefore $r'/r = 0.25$. In Figure 2 the value of \bar{C}_e for $r'/r = 0.25$ is given as 1.017. Hence, the required corrected average tumour-air ratio, $\bar{R}' = 0.721 \times 1.017 = 0.733$.

SUMMARY

Tables of averaged tumour-air ratios in terms of the anteroposterior dimension and the ratio of the lateral to the anteroposterior dimensions of the patient are presented for cobalt-60 radiation, 360° rotation, and 16 field sizes. The method by which the tables were calculated is outlined. It depends on the fact that the actual body contour can be replaced by a trigonometric function; the tumour-air ratio, written as a function of the radius, is then integrated around this "idealized" contour. The use of the tables is discussed. The calculation of the tables was carried out on the digital computer FERUT at the Computation Centre of the

University of Toronto. The calculations are based on tumour-air ratios recently published by Johns and his associates (4). A detailed description of the method can be found in an earlier paper by the authors (2).

ACKNOWLEDGMENTS: We are greatly indebted to Dr. George P. Henderson of the Mathematics Department, University of Western Ontario, for programming the problem for FERUT; and to Dr. C. C. Gottlieb of the Computation Centre, University of Toronto, for his help in carrying out the calculations. Again we wish to express our gratitude to Dr. Ivan H. Smith, Director of the London Clinic of the Ontario Cancer Foundation, for his interest and encouragement during the course of this work.

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SUMMARIO IN INTERLINGUA

Proportiones Tumori-Aeree Medie Pro Therapia A Cobalt⁶⁰ In Rotation Per 360 Grados

Tabulas de proportiones tumori-aeree medie in terminos del dimension antero-posterior e le proportion del dimensiones lateral e anteroposterior del patiente es presentate pro therapia a cobalt⁶⁰ in rotation per 360 grados e 16 magnitudes de campo. Es delineate le methodo per que le valores in le tabulas esseva calculate. Le methodo depende del facto que le contorno real del corpore pote esser reimplaciate per un function trigonometric. Postea le

proportion tumori-aeree (scribite como function del radius) es integrate circa le contorno "idealisate."

Le calculation del tabulas esseva executate per medio de un computator digital al Centro de Computation al Universitate Toronto. Le calculationes es basate super le proportiones tumori-aeree recentemente publicate per Johns *et al.* (4). Un description detaliata del methodo es a trovar in un previe reporto per le autores.

TABLES I-XVII

TABLE I: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; Field 4 × 4 CM.

b	k →	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.778	0.764	0.751	0.738	0.725	0.712	0.700	0.688	0.679	
7.0	0.733	0.718	0.703	0.688	0.674	0.661	0.647	0.635	0.625	
8.0	0.690	0.673	0.657	0.642	0.627	0.612	0.598	0.585	0.575	
9.0	0.649	0.631	0.615	0.598	0.583	0.567	0.553	0.539	0.529	
10.0	0.610	0.592	0.574	0.557	0.541	0.526	0.511	0.497	0.487	
11.0	0.574	0.555	0.536	0.519	0.503	0.487	0.472	0.458	0.448	
12.0	0.539	0.520	0.501	0.483	0.467	0.451	0.436	0.422	0.412	
13.0	0.507	0.487	0.468	0.450	0.434	0.418	0.403	0.389	0.379	
14.0	0.476	0.456	0.437	0.419	0.403	0.387	0.373	0.359	0.349	
15.0	0.447	0.427	0.408	0.391	0.374	0.359	0.344	0.331	0.322	
16.0	0.420	0.400	0.381	0.364	0.348	0.333	0.319	0.305	0.296	

TABLE II: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 4 × 6 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.793	0.780	0.766	0.753	0.741	0.728	0.716	0.704	0.695
7.0	0.749	0.734	0.719	0.704	0.690	0.676	0.663	0.650	0.641
8.0	0.706	0.689	0.673	0.658	0.642	0.628	0.614	0.600	0.590
9.0	0.665	0.647	0.630	0.613	0.598	0.582	0.568	0.554	0.543
10.0	0.626	0.607	0.589	0.572	0.556	0.540	0.525	0.511	0.500
11.0	0.589	0.569	0.551	0.533	0.517	0.501	0.486	0.471	0.461
12.0	0.554	0.534	0.515	0.497	0.480	0.464	0.449	0.435	0.425
13.0	0.521	0.501	0.482	0.464	0.447	0.431	0.416	0.401	0.391
14.0	0.490	0.469	0.450	0.432	0.415	0.399	0.385	0.371	0.361
15.0	0.461	0.440	0.421	0.403	0.386	0.371	0.356	0.342	0.332
16.0	0.433	0.413	0.393	0.376	0.359	0.344	0.329	0.316	0.306

TABLE III: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 4 × 8 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.801	0.788	0.775	0.762	0.749	0.737	0.724	0.712	0.704
7.0	0.757	0.742	0.727	0.713	0.699	0.685	0.672	0.659	0.649
8.0	0.715	0.698	0.682	0.667	0.651	0.637	0.623	0.609	0.599
9.0	0.674	0.656	0.639	0.623	0.607	0.591	0.577	0.563	0.552
10.0	0.635	0.616	0.598	0.581	0.565	0.549	0.534	0.520	0.509
11.0	0.598	0.579	0.560	0.542	0.526	0.510	0.494	0.480	0.469
12.0	0.563	0.543	0.524	0.506	0.489	0.473	0.458	0.443	0.433
13.0	0.530	0.510	0.490	0.472	0.455	0.439	0.424	0.410	0.399
14.0	0.499	0.478	0.459	0.441	0.424	0.408	0.393	0.378	0.368
15.0	0.469	0.449	0.429	0.411	0.394	0.378	0.364	0.350	0.340
16.0	0.442	0.421	0.402	0.384	0.367	0.351	0.337	0.323	0.314

TABLE IV: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 4 × 10 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.807	0.794	0.781	0.768	0.755	0.743	0.731	0.719	0.710
7.0	0.764	0.749	0.734	0.719	0.705	0.692	0.678	0.665	0.656
8.0	0.721	0.705	0.688	0.673	0.658	0.643	0.629	0.615	0.605
9.0	0.680	0.662	0.645	0.629	0.613	0.598	0.583	0.569	0.559
10.0	0.641	0.623	0.605	0.587	0.571	0.555	0.540	0.526	0.515
11.0	0.604	0.585	0.566	0.549	0.532	0.516	0.501	0.486	0.476
12.0	0.569	0.549	0.530	0.512	0.495	0.479	0.464	0.449	0.439
13.0	0.536	0.516	0.497	0.478	0.461	0.445	0.430	0.415	0.405
14.0	0.505	0.484	0.465	0.447	0.430	0.414	0.398	0.384	0.374
15.0	0.475	0.455	0.435	0.417	0.400	0.384	0.369	0.355	0.345
16.0	0.448	0.427	0.408	0.390	0.373	0.357	0.342	0.329	0.319

TABLE V: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 4 × 15 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.813	0.800	0.788	0.775	0.763	0.750	0.739	0.727	0.718
7.0	0.771	0.756	0.742	0.728	0.714	0.700	0.687	0.674	0.665
8.0	0.729	0.713	0.697	0.682	0.667	0.653	0.639	0.625	0.616
9.0	0.689	0.672	0.655	0.639	0.623	0.608	0.594	0.580	0.569
10.0	0.651	0.633	0.615	0.598	0.582	0.566	0.551	0.537	0.527
11.0	0.615	0.596	0.577	0.560	0.543	0.527	0.512	0.498	0.487
12.0	0.580	0.560	0.542	0.524	0.507	0.491	0.476	0.461	0.451
13.0	0.547	0.527	0.508	0.490	0.473	0.457	0.442	0.427	0.417
14.0	0.516	0.496	0.477	0.459	0.442	0.426	0.410	0.396	0.386
15.0	0.487	0.467	0.447	0.429	0.412	0.396	0.381	0.367	0.357
16.0	0.460	0.439	0.420	0.402	0.385	0.369	0.354	0.340	0.331

TABLE VI: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 5 × 5 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.795	0.782	0.769	0.756	0.743	0.731	0.718	0.706	0.697
7.0	0.751	0.736	0.721	0.707	0.693	0.679	0.666	0.653	0.643
8.0	0.708	0.692	0.676	0.660	0.645	0.630	0.616	0.603	0.593
9.0	0.667	0.650	0.633	0.616	0.600	0.585	0.570	0.556	0.546
10.0	0.628	0.610	0.592	0.575	0.558	0.543	0.528	0.513	0.503
11.0	0.591	0.572	0.554	0.536	0.519	0.503	0.488	0.474	0.463
12.0	0.556	0.537	0.518	0.500	0.483	0.467	0.452	0.437	0.427
13.0	0.523	0.503	0.484	0.466	0.449	0.433	0.418	0.404	0.393
14.0	0.492	0.472	0.453	0.434	0.418	0.402	0.387	0.373	0.362
15.0	0.463	0.442	0.423	0.405	0.388	0.373	0.358	0.344	0.334
16.0	0.435	0.415	0.396	0.378	0.361	0.346	0.331	0.318	0.308

TABLE VII: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 6 × 6 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.808	0.795	0.782	0.770	0.757	0.745	0.732	0.720	0.712
7.0	0.765	0.750	0.735	0.721	0.707	0.693	0.680	0.667	0.658
8.0	0.723	0.706	0.690	0.675	0.660	0.645	0.631	0.617	0.607
9.0	0.682	0.664	0.647	0.631	0.615	0.600	0.585	0.571	0.561
10.0	0.643	0.625	0.607	0.590	0.573	0.558	0.543	0.528	0.518
11.0	0.606	0.587	0.569	0.551	0.534	0.518	0.503	0.488	0.478
12.0	0.571	0.552	0.533	0.515	0.498	0.481	0.466	0.452	0.441
13.0	0.538	0.518	0.499	0.481	0.464	0.447	0.432	0.418	0.407
14.0	0.507	0.487	0.467	0.449	0.432	0.416	0.401	0.386	0.376
15.0	0.478	0.457	0.438	0.419	0.402	0.386	0.371	0.357	0.347
16.0	0.450	0.429	0.410	0.392	0.375	0.359	0.344	0.331	0.321

TABLE VIII: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 6 × 8 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.821	0.808	0.795	0.783	0.770	0.758	0.746	0.734	0.725
7.0	0.778	0.764	0.749	0.735	0.721	0.707	0.694	0.681	0.672
8.0	0.737	0.720	0.704	0.689	0.674	0.659	0.645	0.631	0.621
9.0	0.696	0.679	0.662	0.645	0.629	0.614	0.599	0.585	0.575
10.0	0.657	0.639	0.621	0.604	0.587	0.572	0.556	0.542	0.531
11.0	0.621	0.601	0.583	0.565	0.548	0.532	0.516	0.502	0.491
12.0	0.586	0.566	0.547	0.528	0.511	0.495	0.479	0.465	0.454
13.0	0.552	0.532	0.513	0.494	0.477	0.461	0.445	0.430	0.420
14.0	0.521	0.500	0.481	0.462	0.445	0.429	0.413	0.399	0.388
15.0	0.491	0.470	0.451	0.432	0.415	0.399	0.384	0.369	0.359
16.0	0.463	0.442	0.422	0.404	0.387	0.371	0.356	0.342	0.332

TABLE IX: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 6 × 10 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.827	0.814	0.802	0.789	0.777	0.765	0.753	0.741	0.732
7.0	0.785	0.770	0.756	0.742	0.728	0.715	0.702	0.689	0.679
8.0	0.744	0.728	0.712	0.697	0.682	0.667	0.653	0.639	0.629
9.0	0.704	0.686	0.670	0.653	0.637	0.622	0.607	0.593	0.583
10.0	0.665	0.647	0.629	0.612	0.596	0.580	0.565	0.550	0.540
11.0	0.629	0.609	0.591	0.573	0.556	0.540	0.525	0.510	0.499
12.0	0.594	0.574	0.555	0.537	0.520	0.503	0.488	0.473	0.462
13.0	0.561	0.540	0.521	0.503	0.485	0.469	0.453	0.438	0.428
14.0	0.529	0.509	0.489	0.471	0.453	0.437	0.421	0.407	0.396
15.0	0.500	0.479	0.459	0.440	0.423	0.407	0.391	0.377	0.367
16.0	0.472	0.450	0.431	0.412	0.395	0.379	0.364	0.350	0.340

TABLE X: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 6 × 15 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.839	0.827	0.814	0.802	0.790	0.778	0.766	0.755	0.746
7.0	0.798	0.784	0.770	0.756	0.742	0.729	0.716	0.703	0.694
8.0	0.758	0.742	0.726	0.711	0.696	0.682	0.668	0.654	0.644
9.0	0.718	0.701	0.684	0.668	0.652	0.637	0.622	0.608	0.598
10.0	0.680	0.662	0.644	0.627	0.610	0.595	0.579	0.565	0.554
11.0	0.644	0.624	0.606	0.588	0.571	0.555	0.539	0.525	0.514
12.0	0.609	0.589	0.570	0.552	0.534	0.518	0.502	0.487	0.476
13.0	0.576	0.555	0.536	0.517	0.500	0.483	0.467	0.452	0.442
14.0	0.544	0.523	0.504	0.485	0.467	0.451	0.435	0.420	0.409
15.0	0.514	0.493	0.473	0.455	0.437	0.420	0.405	0.390	0.380
16.0	0.486	0.465	0.445	0.426	0.409	0.392	0.377	0.362	0.352

TABLE XI: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 8 × 8 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.834	0.821	0.808	0.796	0.783	0.771	0.759	0.747	0.739
7.0	0.792	0.777	0.762	0.748	0.734	0.721	0.708	0.695	0.685
8.0	0.750	0.734	0.718	0.702	0.687	0.673	0.659	0.645	0.635
9.0	0.710	0.692	0.675	0.659	0.643	0.627	0.613	0.598	0.588
10.0	0.671	0.653	0.635	0.617	0.601	0.585	0.570	0.555	0.544
11.0	0.634	0.615	0.596	0.578	0.561	0.545	0.530	0.515	0.504
12.0	0.599	0.579	0.560	0.542	0.524	0.508	0.492	0.477	0.467
13.0	0.566	0.545	0.526	0.507	0.490	0.473	0.458	0.443	0.432
14.0	0.534	0.513	0.494	0.475	0.458	0.441	0.425	0.411	0.400
15.0	0.504	0.483	0.463	0.445	0.427	0.411	0.396	0.381	0.371
16.0	0.476	0.455	0.435	0.417	0.399	0.383	0.368	0.354	0.344

TABLE XII: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 8 × 10 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.844	0.831	0.819	0.807	0.795	0.783	0.771	0.759	0.751
7.0	0.803	0.788	0.774	0.760	0.747	0.733	0.720	0.707	0.698
8.0	0.762	0.746	0.731	0.715	0.700	0.686	0.672	0.658	0.648
9.0	0.723	0.705	0.688	0.672	0.656	0.641	0.626	0.611	0.601
10.0	0.684	0.666	0.648	0.631	0.614	0.598	0.583	0.568	0.557
11.0	0.648	0.628	0.610	0.592	0.574	0.558	0.542	0.527	0.516
12.0	0.612	0.592	0.573	0.555	0.537	0.521	0.505	0.489	0.479
13.0	0.579	0.558	0.539	0.520	0.502	0.485	0.469	0.454	0.444
14.0	0.547	0.526	0.506	0.487	0.469	0.453	0.437	0.422	0.411
15.0	0.517	0.496	0.475	0.457	0.439	0.422	0.406	0.392	0.381
16.0	0.488	0.467	0.447	0.428	0.410	0.394	0.378	0.364	0.353

TABLE XIII: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 8 × 15 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.856	0.844	0.832	0.821	0.809	0.797	0.786	0.775	0.766
7.0	0.817	0.803	0.789	0.776	0.763	0.749	0.737	0.724	0.715
8.0	0.778	0.762	0.747	0.732	0.717	0.703	0.689	0.675	0.665
9.0	0.739	0.722	0.706	0.689	0.674	0.658	0.644	0.629	0.619
10.0	0.702	0.683	0.666	0.649	0.632	0.616	0.601	0.586	0.575
11.0	0.665	0.646	0.628	0.610	0.593	0.576	0.561	0.545	0.534
12.0	0.631	0.611	0.591	0.573	0.564	0.539	0.523	0.508	0.497
13.0	0.597	0.577	0.557	0.538	0.604	0.504	0.487	0.472	0.461
14.0	0.566	0.544	0.524	0.505	0.488	0.471	0.454	0.439	0.428
15.0	0.535	0.514	0.494	0.475	0.457	0.440	0.424	0.409	0.398
16.0	0.507	0.485	0.465	0.446	0.428	0.411	0.395	0.380	0.370

TABLE XIV: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 10 × 10 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.854	0.842	0.830	0.818	0.806	0.795	0.783	0.772	0.763
7.0	0.814	0.800	0.787	0.773	0.760	0.746	0.733	0.720	0.711
8.0	0.775	0.759	0.744	0.729	0.714	0.699	0.685	0.672	0.662
9.0	0.736	0.719	0.702	0.686	0.670	0.655	0.640	0.625	0.615
10.0	0.698	0.680	0.662	0.645	0.628	0.612	0.597	0.582	0.571
11.0	0.662	0.642	0.624	0.606	0.588	0.572	0.556	0.541	0.530
12.0	0.626	0.606	0.587	0.569	0.551	0.534	0.518	0.503	0.492
13.0	0.593	0.572	0.552	0.534	0.516	0.499	0.483	0.467	0.456
14.0	0.561	0.540	0.520	0.501	0.483	0.466	0.449	0.434	0.423
15.0	0.531	0.509	0.489	0.470	0.452	0.435	0.419	0.404	0.393
16.0	0.502	0.480	0.460	0.440	0.422	0.406	0.390	0.375	0.365

TABLE XV: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 10 × 15 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.867	0.856	0.844	0.833	0.821	0.810	0.799	0.788	0.779
7.0	0.829	0.816	0.802	0.789	0.776	0.763	0.750	0.738	0.729
8.0	0.791	0.776	0.761	0.746	0.732	0.718	0.704	0.691	0.681
9.0	0.753	0.737	0.720	0.704	0.689	0.674	0.660	0.645	0.635
10.0	0.716	0.699	0.681	0.665	0.648	0.633	0.617	0.603	0.592
11.0	0.681	0.662	0.644	0.626	0.610	0.593	0.578	0.563	0.552
12.0	0.647	0.627	0.608	0.590	0.573	0.556	0.541	0.525	0.515
13.0	0.614	0.594	0.575	0.556	0.538	0.522	0.506	0.490	0.479
14.0	0.583	0.562	0.542	0.524	0.506	0.489	0.473	0.458	0.447
15.0	0.553	0.532	0.512	0.493	0.475	0.458	0.442	0.427	0.416
16.0	0.525	0.503	0.483	0.464	0.446	0.430	0.414	0.399	0.388

TABLE XVI: AVERAGED TUMOUR-AIR RATIO. Co⁶⁰; FIELD 15 × 15 CM.

<i>b</i>	<i>k</i> → 1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.775
6.0	0.886	0.875	0.864	0.853	0.842	0.831	0.820	0.810	0.802
7.0	0.849	0.836	0.824	0.811	0.798	0.786	0.774	0.762	0.753
8.0	0.813	0.798	0.784	0.770	0.756	0.742	0.729	0.716	0.706
9.0	0.776	0.760	0.745	0.729	0.714	0.700	0.685	0.671	0.661
10.0	0.741	0.724	0.707	0.690	0.674	0.659	0.644	0.630	0.619
11.0	0.707	0.688	0.670	0.653	0.637	0.620	0.605	0.590	0.579
12.0	0.673	0.654	0.635	0.618	0.600	0.584	0.568	0.553	0.542
13.0	0.641	0.621	0.602	0.584	0.566	0.549	0.533	0.518	0.507
14.0	0.610	0.590	0.570	0.552	0.534	0.517	0.501	0.485	0.474
15.0	0.581	0.560	0.540	0.521	0.503	0.486	0.470	0.455	0.444
16.0	0.553	0.532	0.511	0.492	0.474	0.457	0.441	0.426	0.415

TABLE XVII: NUMERICAL VALUES OF THE EMPIRICAL CONSTANTS IN THE TUMOUR-AIR RATIO EQUATION

Field (cm. ²)	A ^{1/2} (cm.)	A ₁	α ₁ (cm. ⁻¹)	A ₂	α ₂ (cm. ⁻¹)
4 × 4	4	1.140	0.06237	-0.189	0.5607
4 × 6	4.90	1.160	0.06157	-0.215	0.5348
4 × 8	5.66	1.170	0.06089	-0.219	0.4945
4 × 10	6.32	1.172	0.06014	-0.228	0.5265
4 × 15	7.75	1.170	0.05838	-0.204	0.4839
5 × 5	5.00	1.165	0.06151	-0.208	0.5020
6 × 6	6.00	1.175	0.05998	-0.194	0.4724
6 × 8	6.93	1.190	0.05895	-0.200	0.4371
6 × 10	7.75	1.196	0.05813	-0.194	0.4061
6 × 15	9.49	1.210	0.05696	-0.214	0.3874
8 × 8	8.00	1.200	0.05776	-0.224	0.4529
8 × 10	8.94	1.225	0.05740	-0.220	0.3657
8 × 15	10.95	1.240	0.05581	-0.240	0.3401
10 × 10	10.00	1.245	0.05666	-0.244	0.3367
10 × 15	12.25	1.230	0.05313	-0.226	0.3532
15 × 15	15.00	1.240	0.05034	-0.212	0.3207

Cobalt-60 Radiation Measurements¹

CARL B. BRAESTRUP and RICHARD T. MOONEY

GAMMA-BEAM measurements of cobalt teletherapy equipment present certain problems not encountered with conventional roentgen-therapy apparatus. The gamma rays are of higher energy and are emitted continuously from a source material of significant dimensions. These factors affect the measurements of the radiation in various ways. The high energy of the gamma rays (1.17 and 1.33 MEV) requires an increase in the wall thickness of the ionization chamber to secure electronic equilibrium; even after electronic equilibrium has been established, the instrument calibration factor

for 200 to 250-kv x-rays cannot be applied to the higher-energy radiation. Since the gamma radiation is emitted continuously, the safety of personnel is dependent upon adequate shielding of the source housing; accurate measurements of the leakage radiation are therefore required. The useful beam measurements are affected by the type of beam control and a correction may be necessary for the exposure received during the opening and closing of the shutter or while the source is moving between the "off" and "on" positions. In addition, cobalt-60 sources have finite dimensions so that the terms "source

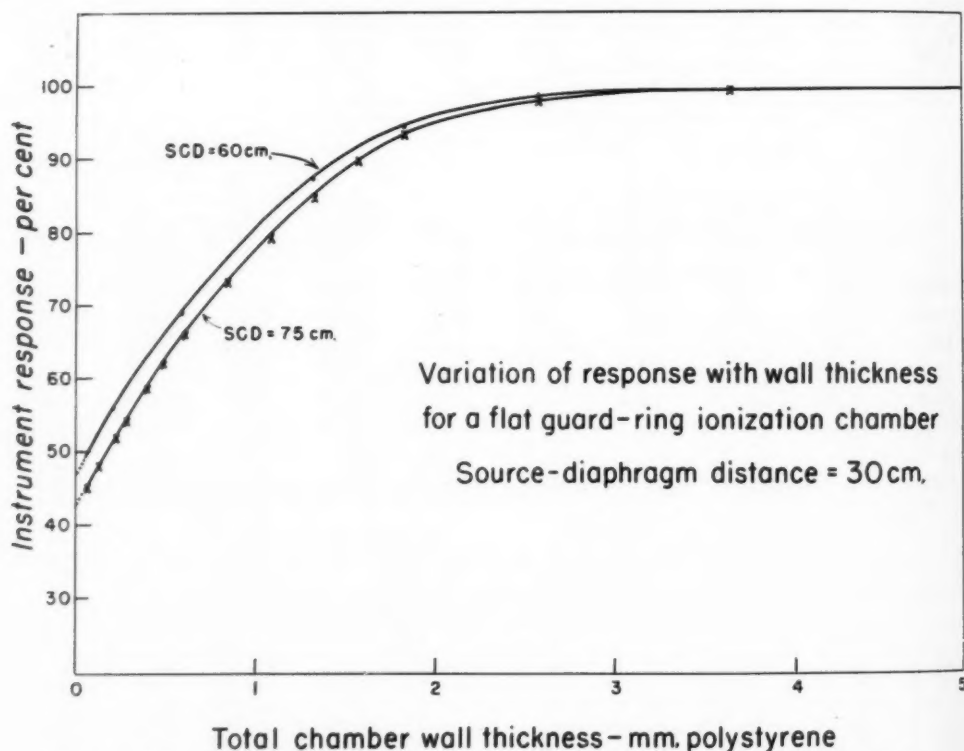


Fig. 1. Effect of chamber wall thickness on the response of a guard-ring type ionization chamber.

¹ From the Physics Laboratory, Francis Delafield Hospital, New York, N. Y. Presented as part of a Symposium on Cobalt-60 Therapy at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

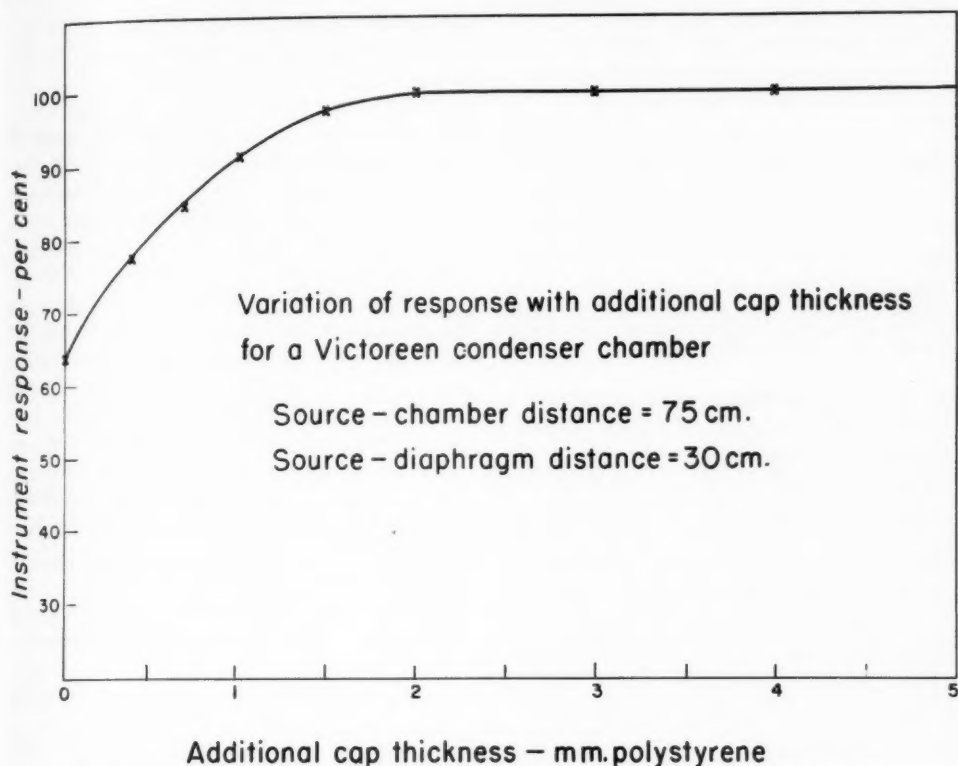


Fig. 2. Effect of additional wall thickness on the response of a Victoreen condenser chamber.

distance" and "field size" have ambiguous meanings.

In order to permit the duplication of technics between various teletherapy clinics, it is desirable that certain standard procedures be adopted. This problem is already being considered by Subcommittee M-2 of the National Committee on Radiation Protection and Measurements. The purpose of the present paper is to present the results of a study made of the above-mentioned factors.

ELECTRONIC EQUILIBRIUM

Condenser chambers used to obtain the air exposure dose must be constructed so as to conform with the requirements implicit in the definition of the roentgen. That is, there must be as many electrons entering the air volume as there are leaving it. To establish this condition, an equilibrium wall thickness is required. For the

high-energy gamma rays from cobalt 60, the wall thickness of the conventional chamber is insufficient. Figure 1 shows the variation of instrument response with wall thickness for a flat guard-ring type ionization chamber with a 1.5-mm. air spacing. The minimum wall thickness was 0.05 mm. polystyrene. The initial slope of the curves is an indication of the electron contamination of the beam. This contamination increases as the distance from the collimating system is decreased. It will be noted that a total wall thickness of 4.0 mm. is required to obtain maximum ionization in the chamber. It was found that the wall thickness had to be increased to about 8 mm. before the absorption of the gamma rays caused a significant reduction in instrument response.

The variation of the response of a Victoreen condenser chamber with additional cap thickness is shown in Figure 2. As

CHAMBER	SECTIONS OF CONDENSER CHAMBER					TOTAL STEM LEAKAGE
	1	2	3	4	5	
25r	100	1.28	.31	.51	.43	2.53
100r	100	1.38	1.15	2.07	3.56	8.16
250r	100	5.88	3.24	5.88	9.42	24.42

Fig. 3. Effect of leakage current through the insulator and of ionization in the extracavity air gaps of 25-, 100-, and 250-r condenser chambers, expressed in per cent of the thimble-chamber reading.

indicated, an added cap thickness of 2 to 3 mm. polystyrene is required to establish electronic equilibrium.

The ratio of the response of a condenser chamber with and without an equilibrium wall will give a measure of the electron contamination of the beam. A high degree of electron contamination will cause the maximum ionization to occur at the skin of the patient instead of in the subcutaneous regions. In such cases, the use of electron filters should be considered (1).

WAVE-LENGTH DEPENDENCE OF CONDENSER IONIZATION CHAMBERS

Condenser chamber calibration factors for cobalt 60, based upon the radium emission constant, may differ considerably from the calibration factors for 250-kv x-rays. Table I shows the results of

TABLE I: CALIBRATION FACTORS FOR VICTOREEN r-METERS

Calibration Performed at	25-r Chamber	X-rays		Cobalt 60 h.v.l. 11 mm. Pb
		h.v.l. 0.9 mm. Al	h.v.l. 2.0 mm. Cu	
National Bureau of Standards	#2533	...	1.07	1.22
Delafield Hospital	#2533	1.16	1.06	1.21
Delafield Hospital	#X-129	1.11	1.00	1.05

calibrations performed at the National Bureau of Standards and at Delafield Hospital. Two Victoreen condenser chambers were exposed to the gamma rays of cobalt 60 and x-rays of 2.0 mm. Cu and 0.9 mm. Al half-value layer. The results

indicate a difference of as much as 15 per cent in the calibration factors for 250-kv x-rays and cobalt-60 gamma rays.

It has been suggested that this difference in sensitivity is due to small amounts of high-atomic-number material purposely incorporated in the wall or the collector rod of the chamber in order to reduce its wave-length dependence over the conventional region of x-ray energies. To investigate this possibility, a condenser thimble chamber, constructed in this laboratory, was calibrated before and after replacing the original carbon collector rod with an aluminum rod. The r-meter had been previously calibrated for the gamma rays of cobalt 60 by the U. S. National Bureau of Standards and the National Research Council of Canada. There was less than 1 per cent variation in the calibration factor after the appropriate temperature and pressure corrections were applied.

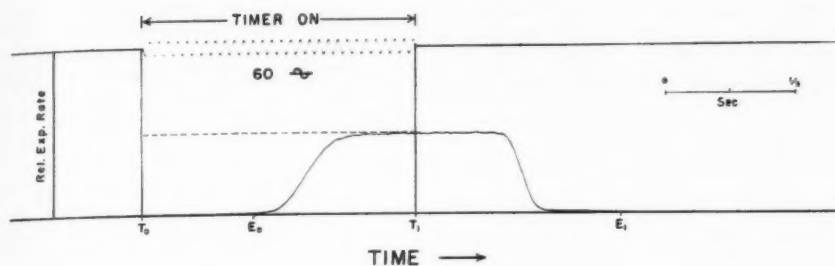
TABLE II: CALIBRATION FACTORS FOR BRAESTRUP TYPE r-METER

Collector Material	25-r Chamber	X-rays		Cobalt 60 h.v.l. 11 mm. Pb
		h.v.l. 0.9 mm. Al	h.v.l. 2.0 mm. Cu	
Carbon	#5310	1.02	0.94	0.96
Aluminum	#5310	0.88	0.86	0.96

The variation in calibration factor for the two conditions is shown in Table II. The aluminum collector increases the ionization in the chamber by 14 per cent for a half-value layer of 0.9 mm. Al as compared with an increase of 9 per cent for a half-value layer of 2.0 mm. Cu. On the other hand, the calibration factor for cobalt 60 is unaffected by the change. Since the Victoreen chamber has an aluminum collector, the presence of this relatively high-atomic-number material may at least partially explain the variation indicated in Table I.

CONDENSER CHAMBER STEM LEAKAGE

In the determination of the air exposure dose rate for the various field sizes used in



VARIATION OF AIR EXPOSURE DOSE RATE WITH TIME.
MOVABLE SHUTTER BEAM CONTROL
10 x 10-cm FIELD at 75 cm.

Fig. 4. Oscillogram showing the variation of the air exposure dose rate with time for a teletherapy apparatus utilizing a movable shutter for beam control.

teletherapy, consideration should be given to the possibility of chamber stem leakage. By increasing the field, a greater part of the stem is irradiated so that the leakage current through the insulator and ionization in the extracavity air gaps may result in an erroneous high exposure rate. In order to investigate the magnitude of this effect, stem sections of Victoreen chambers were irradiated. Two lead cylinders, 15 cm. in diameter, were placed 3.5 cm. apart, shielding the chamber and stem except for the section under investigation. When the thimble was in the useful beam, the air volume in the thimble was replaced by polystyrene. The results are shown in Figure 3 for the 25-, 100-, and 250-r Victoreen chambers. As indicated, the total stem leakage, including the extracavity ionization for a 250-r chamber, can be as high as 24 per cent when the entire chamber is irradiated. The resulting variation in sensitivity with field size limits the practical usefulness of the 100- and 250-r chambers for measuring high-energy radiation.

BEAM CONTROL

As previously stated, useful beam measurements are affected by the type of beam control utilized in a given teletherapy unit.

Movable Shutter: This type of beam control usually consists of a sliding block which is pulled from in front of the source by a

pneumatic piston and returned by a spring (2). The treatment timer activates a solenoid, which in turn causes pressure to be applied to the face of the piston in the cylinder. The shutter moves with the piston against the action of the spring. The variation of the air exposure dose rate with time as the shutter moves is shown in Figure 4.

The results were obtained by utilizing a guard-ring type thimble chamber and a recording oscillograph. The circuit was arranged so that a 60-cycle timing wave was applied to the recording galvanometer when the treatment timer was in operation. The response time of the entire measuring system was less than 0.01 second. The complete sequence of events is as follows: At T_0 the timer starts, pneumatic pressure is applied to the cylinder, and the shutter block begins to move. At E_0 part of the source becomes visible and the exposure begins. The exposure reaches a maximum when the entire source becomes visible. At T_1 the timer goes to the "off" position and the spring begins to close the shutter. At E_1 the shutter is fully closed. The total elapsed time indicated by the timer is from T_0 to T_1 , while the duration of the exposure is from E_0 to E_1 .

It is evident that the additional exposure dose delivered during the final transient period when the shutter is closing tends to compensate for the low exposure dose delivered during the initial transient period

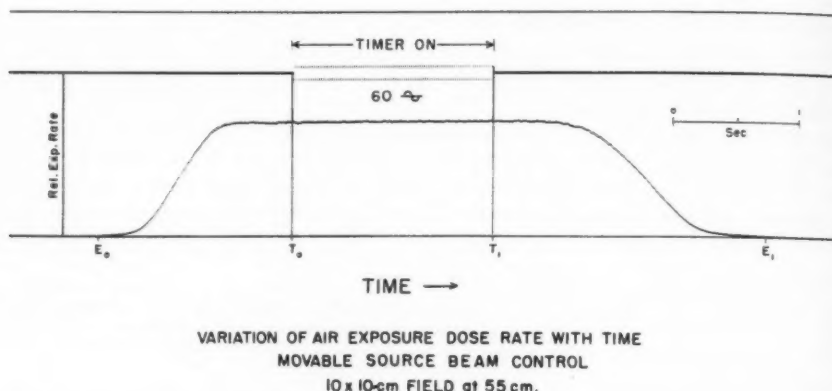


Fig. 5. Oscillogram showing the variation of the air exposure dose rate with time for a teletherapy apparatus utilizing a movable source for beam control.

when the shutter is opening. The degree of compensation depends upon the adjustment of the shutter. Condenser chamber measurements indicate that the compensation is nearly complete; with proper adjustment, the shutter correction is less than 0.2 r.

Movable Source: For teletherapy equipment utilizing a movable source for beam control, the time for the source to move from the "off" to the "on" position may be as long as five or six seconds. This in itself is not a disadvantage if the indicated exposure time begins when the source is in the "on" position and ends when it leaves the "on" position. The variation of the exposure rate with time is shown in Figure 5. The complete sequence of events is as follows: At E_0 the leading edge of the source becomes visible. At T_0 the source is in the center of the aperture ("on" position) and the exposure dose is maximum.

The timer starts at T_0 and stops at T_1 , at which time the source begins to move toward its shielded position. At E_1 the source is no longer visible. As a result, the total integrated exposure exceeds the steady-state exposure for the indicated time. Inasmuch as the transient interval varies with field size, appropriate corrections should be made for each field size used. Figure 6 shows the variation of the cumulative exposure for various

time intervals and fields. As indicated, the corrections are significant, especially for large fields. Satisfactory compensation can be obtained, however, by repositioning the timer switch in the source housing.

SOURCE DISTANCE

Since the height of the cobalt source may vary from less than 1 cm. to more than 2 cm., it is desirable to establish what is meant by source distance. The source distance may be measured from the point of interest to either the nearest point on the source or to the effective center of the source. The NCRP M-2 Subcommittee has tentatively proposed that the source distance be measured along the center line of the beam from the point of interest to the nearest point of the source. This definition has the following advantages: (a) It is consistent with x-ray nomenclature. (b) The nearest point of the source is usually that most easily defined. (c) The source distance remains fixed irrespective of source height.

It would be very advantageous if the manufacturers of cobalt equipment would definitely indicate this point on the outside of the source housing or have stamped on the collimating system the distance to the nearest point of the source.

FIELD SIZE

As the source is not a point, there is no

sharp demarcation of the field size but a gradual reduction in the intensity due to penumbra. Various recommendations have been made as to the definition of field size. These include using either the geometrical field or the intersection of the 80 per cent isodose lines with a plane perpendicular to the central axis. The geometrical field is determined by assuming a point source and describes the geometrical arrangement of the collimating system. By using this definition, the field size can be defined prior to making the isodose measurements. It is realized that the geometrical field size does not give a clear clinical picture of the irradiated volume. This is not a serious objection, however, as the dose distribution in the patient should be determined by the complete isodose pattern for the particular technic used.

AIR EXPOSURE RATE

The determination of the exposure rate in r per minute is not merely of clinical significance; it is also of economic importance, as the trend is toward basing the price of the source on the rmm (r/min at 1 meter). The NCRP M-2 Subcommittee has proposed that the output of the source be determined from measurements made at the center of the field without backscatter at a distance of at least 20 cm. from the end of the collimating system. The field size should be 100 sq. cm. at the distance of measurements. The size of the field is specified, as there is considerable variation in the exposure rate with the cross section of the beam, particularly if the field is reduced below 50 sq. cm. Obviously, for clinical purposes the air exposure rate should be determined for the distance and field size of interest. At Delafield Hospital, we have normalized our depth-dose data to a fixed field size of 100 sq. cm. and, therefore, need only to make decay calculations and repeat measurements for this size.

DEPTH DOSE

In conventional roentgen therapy, the

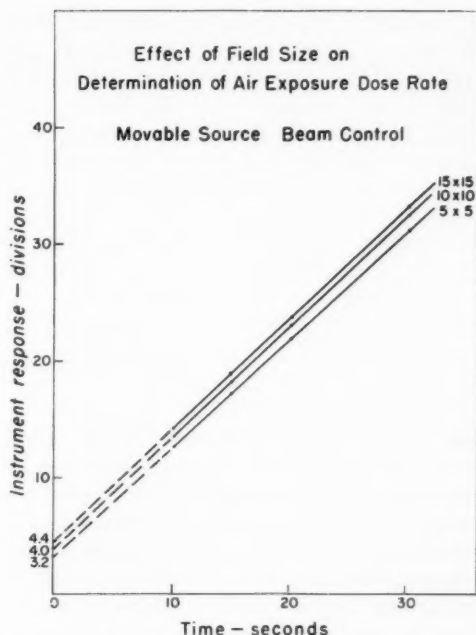


Fig. 6. Graph showing the variation of the cumulative exposure for various time intervals and fields.

tolerance of the skin is usually the limiting factor in delivering an adequate amount of radiation to the deep-seated tumor. The accurate determination of the skin dose is, therefore, of primary importance. In the case of cobalt-60 teletherapy and other forms of supervoltage irradiation, the dose to the skin is of lesser importance, while the dose to critical organs near the tumor usually becomes the limiting factor.

The compactness of cobalt permits its use as a moving source in rotation therapy. In such cases, the dose at the axis is of primary interest. With rotating equipment, it appears more logical to normalize the depth dose to the dose at the axis, calling the axis dose 100 per cent. For stationary equipment, the measurement should be normalized to the level of maximum ionization density. This may be assumed to be 0.4 cm. below the surface.

CONCLUSIONS

The results of this study clearly indicate the need for uniformity in cobalt dosimetry.

The general use of the recommendations at present in course of preparation by the National Committee on Radiation and Measurements will facilitate the proper evaluation and duplication of the various technics employed in cobalt-60 teletherapy.

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SUMMARIO IN INTERLINGUA

Mesurationes Pro Radiation A Cobalt⁶⁰

Le mesuration del fascas gamma de machinas teletherapeutic a cobalt presenta certe problemas que non es incontrate in apparatusas de roentgenotherapiea conventional. Le radios gamma ha un plus alte energia e es emittite continuemente per un fonte material de dimensiones significative. Iste factores affice le mesuration del radiation in varie manieras.

A fin que le technicas empleate in le clinicas teletherapeutic pote esser duplicate, il es desirabile adoptar certe standards de procedimento. In consideration de isto,

un analyse del factores de influencia super le rendimento es prendite in consideration. Iste factores include le equilibrio electronic, le calibration del instrumento, le escappamento ab le camera de condensation, e le regulation del fasce. Es proponite que le distantia del fonte es mesurate per sequer le linea central del fasce ab le puncto de interesse usque al plus proxime puncto del fonte. Altere terminos pro le quales definitiones standard es proponite es le dimension del campo, le exposition aeree, e le dose in profundor.



Radiogold in the Treatment of Cancer of the Cervix¹

WILLARD M. ALLEN, M.D., ALFRED I. SHERMAN, M.D., and H. MARVIN CAMEL, M.D.

THE MAIN OBJECTIVE in the use of radioactive colloidal gold for the treatment of cancer of the cervix is safe, adequate, and convenient irradiation of the pelvic lymph nodes. This is in no way different from the motive behind the use of conventional x-rays, supervoltage x-rays, or the gamma rays of radium or cobalt. The treatment of the primary lesion is no problem. Supplemental therapy is necessary, however, because some patients undoubtedly have cancer in the pelvic lymph nodes which would not be destroyed by direct irradiation of the cervix or by hysterectomy. Radiogold is only an agent for providing supplemental therapy. The properties of radiogold are nearly ideal for this purpose. The short half-life of 2.8 days limits the duration of irradiation. The radioactivity is primarily beta, so that the majority of the effect is restricted to the immediate vicinity of the interstitial injection. Radiogold, however, is especially valuable because of the manner in which the tissues absorb and "fix" the gold. The small colloidal particles are picked up by the lymphatics and filtered out by the pelvic lymph nodes in much the same manner as the cancer cells are disseminated from the primary lesion. Maximum irradiation is therefore provided at the spot where it is most needed—the pelvic lymph nodes. Our own experience leads us to believe that radiogold is safe and convenient and that with its use adequate irradiation can be achieved.

Our first clinical studies with radiogold were made in patients with Stage I cancer of the cervix, in which we thought the chance for cure would be as good from the Wertheim operation as by conventional x-ray and radium therapy. Several patients were injected transvaginally with small doses of radiogold. The lymph nodes were

then removed at the time of the Wertheim procedure and on careful study were found to contain appreciable amounts of radiogold. We then gave gradually increasing amounts of radiogold to other patients to find out what doses could be safely used, how much radiation could be delivered to the lymph nodes, and what the effects on the nodes might be. It was found that a dose of 50 millicuries in each parametrium did not produce undue injury and that the lymph nodes received intense irradiation. This finding, together with the histologic evidence of irradiation and the presence of "dead"-appearing cancer cells in some lymph nodes, convinced us that radiogold could be used successfully for the supplemental treatment of the pelvic lymph nodes and the parametria.

During the first two years we limited our study to Stage I cases but, as we gained confidence in the method, we extended the treatment to Stage II and then to Stage III. The treatment of Stage I and Stage II cases is now fairly well standardized. The primary lesion is first treated in the usual manner, with radium, the total dose ranging between 4,000 and 5,500 mg. hr. About two weeks after the radium application, 50 to 70 millicuries of radiogold are injected *into each parametrium*. Small, thin patients are given only 50 millicuries, whereas larger and more obese patients receive 60 to 70 millicuries. The total dose is diluted to 70 c.c. with saline, and 35 c.c. are usually injected into each parametrium.

About two weeks after the injection of the gold we decide whether or not a Wertheim hysterectomy and pelvic lymphadenectomy are to be done. If the patient is a good surgical risk, we usually operate about four weeks after the gold injection. If, for any reason, she is not to have a Wertheim procedure, the total amount of radiation

¹ From the Department of Obstetrics and Gynecology of the Washington University School of Medicine, St. Louis, Mo. Presented at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

TABLE I: COMPLICATIONS OF TREATMENT WITH RADIOGOLD 1950-1956

Stage	Treatment	No. of Cases	Complications	
			Genito-urinary	Intestinal
I	Gold and radium	35	1	
		77	4 (5.2%)	1 (1.3%)
II	Gold and radium	75	2 (2.6%)	1 (1.3%)
		44	3 (6.8%)	
III	Gold and radium	60	2 (3.3%)	1 (1.6%)
TOTAL		291	12 (4.1%)	3 (1.0%)

Ureteral obstruction, 7; ureterovaginal fistula, 3; vesicovaginal fistula, 2; rectovaginal fistula, 1; rectal perforation, 1; large bowel obstruction, 1.

which she has already received is reviewed to determine whether a second radium application is desirable. Usually a second radium application is necessary. This is done about two weeks following the injection of the gold, the dose being almost always less than that from the first radium implant. The exact amount is calculated from the measurements obtained by use of a scintillation counter at the time of each radium implant and at the injection of the radiogold. These measurements are of great value in planning the irradiation. We try to keep the total gamma irradiation of the bladder and rectum below 6,000 gamma roentgens. The treatment of Stage III lesions is essentially the same, except that the Wertheim operation is not done and the total amount of irradiation is pushed to the maximum.

This method of treatment gives much more irradiation of the parametria and pelvic lymph nodes than can be accomplished by conventional 250-kv x-ray and radium treatment. The gamma component of the gold by itself delivers about 2,000 gamma roentgens to the parametria. In addition, the lymph nodes receive intense local irradiation from the beta component of the gold. This varies from about 4,000 to 80,000 rep per gram of nodal tissue. One might expect, therefore, more injuries to the ureter than are observed from x-ray and radium therapy. At the same time, we should expect a higher cure-rate because of better sterilization of the pelvic lymph

nodes (1). The problem, then, is to survey the cure-rate and the complications of the treatment with radiogold and radium and compare the findings with the results from x-ray and radium.

The complications directly related to the treatment have been infrequent, and those that have occurred were sustained for the most part in the earlier years of the study (Table I). During the first seven years, 291 patients were treated with radiogold. In this series there were 3 ureterovaginal fistulas, 2 vesicovaginal fistulas, and 7 cases of ureteral obstruction of sufficient degree to warrant treatment. These serious injuries were treated by various procedures such as transplantation of the ureters to a loop of ileum (ileal bladder), reimplantation in the bladder, and in one case by resection of the obstruction and anastomosis of the ureter. The fistulas occurred exclusively in the cases subjected to the Wertheim operation. The incidence is not high, as there were only 5 fistulas in 121 operations. The serious rectal complications were minimal—only 3 cases. There is however, another annoying complication. Most patients treated with radiogold have neuritic pain which arises from irradiation of the obturator nerves and the nerves forming the sacral plexus. This pain usually disappears after two or three weeks. The complications from radiogold can not be attributed exclusively to the gold, except of course for the neuritis, as the patients who sustained serious complications

received radium as well, and many were also subjected to the Wertheim operation.

Careful study of the lymph nodes in the Wertheim cases has provided us with considerable valuable information. The incidence of positive lymph nodes was 10.4 per cent in Stage I, 29.5 per cent in Stage II, and 100 per cent (2 cases) in Stage III (Table II). The presence of positive nodes provides, of course, definite evidence that treatment with radiogold does not destroy all visible evidence of cancer. The lymphadenectomy carried out in these patients has been fairly complete, so that the incidence does give some indication of what the salvage should be in cases not subjected to operation. In this connection it is perhaps more than a coincidence that the three- to seven-year corrected salvage in patients treated with only radium and gold is 89.5 per cent in Stage I and 69.2 per cent in Stage II. This result lends strong support to the idea that failure to sterilize the pelvic lymph nodes results in loss of the patient from cancer. On the other hand, the end-results obtained in the group treated by radiogold and radium and then subjected to surgery gives us some evidence regarding the value of the operation. The three- to seven-year corrected salvage of the operated patients is 92.1 per cent in Stage I and 84.2 per cent in Stage II. This is suggestive evidence that the removal of the pelvic lymph nodes, when they contain

TABLE II: INCIDENCE OF POSITIVELY IDENTIFIED METASTASES IN REMOVED LYMPH NODES AND SURVIVAL RATES

Stage	No. Treated with Nodes Removed	No. with Positive Nodes	Survival without Evidence of Disease
I	77	8 (10.4%)	5 (62.5%)
II	44	13 (29.5%)	10 (77%)
III	2	2 (100%)	2 (100%)
TOTAL	123	23	17 (73.9%)

tumor, does enhance the survival rate in Stage II cases but probably not in Stage I cases (Table III). Furthermore, the survival rate in the 23 cases with positive nodes at operation is 74 per cent. These data suggest, therefore, that more patients with Stage II and Stage III lesions should be subjected to pelvic lymphadenectomy and the Wertheim operation after irradiation, with the hope that salvage can be even further increased.

The overall three- to seven-year salvage rate in 175 cases treated with radiogold is appreciably better than the five-year salvage rate in patients treated with x-ray and radium, especially in Stage II and Stage III. The salvage rate in the gold series is 85.3 per cent in Stage I (88 cases), 69.4 per cent in Stage II (62 cases), and 52 per cent in Stage III (25 cases). These figures include as dead 7 patients lost to follow-up, 3 who have died of other causes, and 1 with

TABLE III. CASES TREATED AND FOLLOWED THREE TO SEVEN YEARS

Stage	Radium and Gold			Radium, Gold, and Wertheim		
	No. Treated	Alive without Disease	Recovery Rate	No. Treated	Alive without Disease	Recovery Rate
I	19	17	89.5	63	58	92.1
II	39	27	69.2	19	16	84.2
III	24	13	54.0	...	...	...
Total	82	57	69.5	82	74	90.2
Stage	All cases. Radium and gold with and without Wertheim			Not counted as treated:		
I	82	75	91.5	7 lost to follow-up		
II	58	43	74.1	3 dying of other disease with no cancer at autopsy		
III	24	13	54.0	1 alive with carcinoma of the breast and lung metastases		
Total	164	131	79.9			

cancer of the breast with lung metastases. The corrected salvage referred to in the previous paragraph excludes these 11 patients. The comparable five-year salvage rates in the patients treated with x-ray and radium in the preceding seven-year period are 80 per cent in Stage I (130 cases), 46 per cent in Stage II (174 cases), and 21 per cent in Stage III (87 cases). In similar vein, the salvage rate in those patients treated with x-ray and radium, while the study with gold has been in progress, are the same as in the larger series treated with x-ray and radium prior to 1950. There can be no doubt, therefore, that we have materially increased the salvage since we have used radiogold for the irradiation of the pelvic lymph nodes and the parametria.

The use of radiogold has several advantages over external deep therapy. First of all, the cost is no greater than with x-ray therapy or with other forms of external irradiation. Second, the reaction in the patient is minimal. There is little or no nausea and no diarrhea from the treatment. Third, any good resident in gynecology can be taught the injection technic in a few months, and a person with experience in the treatment of cancer can become proficient in an even shorter period of time.

Finally, our experience with radiogold gives us the right to make a few speculations. We know that we have reached the maximum tolerable dose with 50 to 70 millicuries in each parametrium. This

provides about 2,000 gamma roentgens to the midparametrium. When this value is increased by 3,000 gamma roentgens from the radium applications, the gamma dose is still probably less than enough to sterilize the pelvic lymph nodes. We base this on our own figures, which indicate that the dose required to sterilize the cervix is 8,000 to 10,000 r. The effectiveness of the gold, then, is probably due to the intense beta irradiation within the lymph nodes. When we consider the complications which may arise from delivering 6,000 or more roentgens to the entire pelvis with such agents as the betatron, we can see that the likelihood of securing better results with supervoltage machines or from teleradium and telecobalt than with radiogold seems rather remote. Further increase in salvage of patients with cancer of the cervix will come from earlier diagnosis, so that a larger percentage of the patients will be seen while the disease is still confined to the cervix. The ideal, of course, will be reached when we have ways and means of removing the uterus in patients with carcinoma *in situ*, just before the lesion becomes invasive.

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SUMMARIO IN INTERLINGUA

Auro Radioactive In Le Tractamento De Carcinoma Del Cervice

He essite constatate que auro radioactive es un salve e convenientemente agente pro le irradiation del nodos lymphatic pelvic in carcinoma cervical. Illo provide un irradiation adequate. In casos del Stadios I e II, le patiente es tractate initialmente con radium, e circa duo septimanas plus tarde 50 a 70 millicuries de auro radioactive es introducite in cata parametrio. Isto es sequite post circa quatro septimanas per le operation de Wertheim (si le

caso se presta a un tal) o per un nove therapia a radium. Lesiones del Stadio III es tractate similmente, excepte que le operation non es effectuate e que le quantitate total del radiation es augmentate usque al maximo possibile.

Iste methodo de tractamento applica multo plus radiation al parametrios e al nodos pelvic que lo que pote esser effectuate per radios X conventional o per therapia a radium. Tamen, illo non destrue omne

signos visibile de cancro. Nodos lymphatic excidite subsequentemente ha resultate in constataciones positive in 9 pro cento del casos de Stadio I e in 29,5 pro cento del casos de Stadio II. Le superviventia trienne a septenne in patientes tractate solamente con radium e auro esseva 89,5 pro cento pro patientes de Stadio I e 69,2 pro cento pro patientes de Stadio II. Le cifras correspondente pro patientes qui esseva operate subsequentemente esseva 92,1 pro cento e 8,2 pro cento.

Le salvation general pro patientes trac-

tate con auro radioactive esseva: pro 88 casos de Stadio I, 85,3 pro cento; pro 62 casos de Stadio II, 69,4 pro cento; pro 25 casos de Stadio III, 52 pro cento. Le comparable valores de superviventia quin-quenne inter patientes tractate con radios X e radium durante le precedente periodo de septe annos esseva 80 pro cento pro Stadio I (130 casos), 46 pro cento pro Stadio II (174 casos), e 21 pro cento pro Stadio III (87 casos).

Le complicationes in therapia a auro esseva paucio numerose.



Ascaris Ileus in Children¹

JAMES I. McCORT, M.D.

OBSTRUCTION of the intestinal tract by a coiled mass of *Ascaris lumbricoides* is a rare but serious occurrence in infancy and childhood. When large numbers of mature worms migrate from their usual habitat in the jejunum they may form a bolus which will block the intestinal lumen. If the cause of the obstruction is not recognized, and corrected, necrosis of the bowel, perforation, peritonitis, and death may follow (1, 10, 12, 19).

PATHOLOGY

The life cycle of *Ascaris* in man is well documented (6). The eggs pass into the duodenum, where the larvae are hatched. Traversing the wall of the bowel, the larvae enter the portal venous system and lymphatics. Thence they pass to the right heart and are discharged into the pulmonary capillaries, setting up a small localized intra-alveolar inflammation, simulating a Löffler type of pneumonia (6). When the reaction subsides, the larvae ascend the bronchial tree, pass over the epiglottis, and again enter the intestinal tract. Between the sixtieth and seventy-fifth day the mature worms mate, and the females begin their egg laying.

The study of Cort, Otto, and Spindler (3) on *Ascaris* infestation in Virginia indicates that the most likely reservoir of infection is excreta present in the moist, shady soil around dwellings and play areas, as a result of lack of toilet training or absence of toilet facilities for children.

Two stages in the life cycle of the worm may produce symptoms: first, the larval stage, when deposition and inflammation take place in the alveoli; second, when the adult worms are lodged in the small bowel (4). In the latter stage, toxins may be liberated, producing a systemic reaction. If the mature worms migrate in sufficient numbers, an obstruction of the bowel may



Fig. 1. Case I. Film of the abdomen showing multiple linear densities in the region of the descending colon. The ascending colon and several loops of small bowel are dilated.

result. Invasion of the common duct has been known to cause jaundice (15), and invasion of the pancreatic duct, a pancreatitis (8).

What leads the adult worms to migrate within the intestine is subject to speculation. Jenkins and Beach (12) believe that the presence of infection elsewhere in the body or a febrile episode will bring this about. Moore (14) considers, among other possibilities, the mating instinct or the irritation of a vermifuge that does not kill immediately. As a result of their migratory movements, the worms may re-enter the stomach and be regurgitated. More commonly they pass down the intestinal tract to be evacuated in the stool. Rarely, they form a tangled ball which obstructs.

¹ From Santa Clara County Hospital, San Jose, Calif. Accepted for publication in September 1957.

CLINICAL ASPECTS

Practically all reported cases of ileus due to *Ascaris* involve infants and children; our 2 patients were by coincidence each four years old. The families of these children were in the lowest socio-economic bracket. Symptoms due to infection with



Fig. 2. Case I. Enlargement of the mass of worms seen in the descending colon. The individual worms are outlined by the air in the bowel and are of uniform caliber.

worms may be absent or may suggest a mild, chronic, ill defined gastrointestinal upset.

When ileus results from migration of the worms, the affected bowel becomes distended and hyperactive. A cramping and colicky abdominal pain results and will cause the parents to seek medical attention for the child.

CASE REPORTS

CASE I: M. H. L., a 4-year-old girl, was admitted with colicky abdominal pain of six days duration. There had been no vomiting until twenty-four

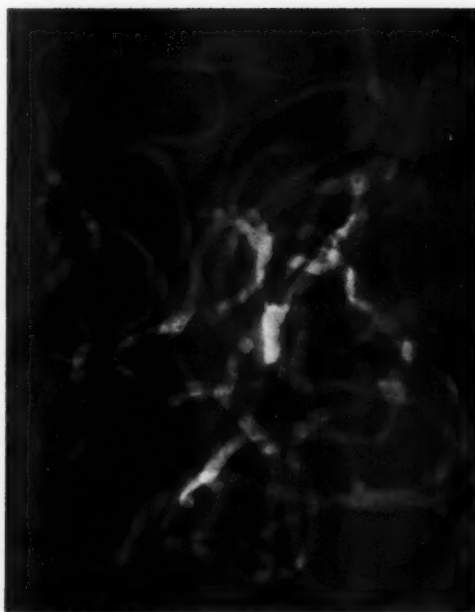


Fig. 3. Case I. Radiograph of the tangled mass of worms found in one bowel movement.

hours before admission. The pain was mid-abdominal and caused the child to double up. A brother had diarrhea. There was a history of ascariasis two years previously in both the patient and her siblings.

Physical examination was essentially negative except for a vaginal discharge. Palpation would cause the child to curl up and clutch her abdomen.

Radiographic examination of the abdomen disclosed the presence of a mass of linear densities in the left side of the colon. The colon and small bowel were moderately distended (Fig. 1).

The white blood cell count was 30,000, with segmented forms 83, lymphocytes 15, mononuclears 2.

The child was treated with Na_2SO_4 and Antipar. The abdomen became soft and nontender. Stool examination showed a large number of adult worms (Fig. 3). Microscopically there were also a large number of ova. No other parasites were found.

CASE II: M. R., a 4-year-old boy, complained of a severe pain in the middle of the abdomen. It had been present on several occasions prior to admission. It had been especially severe in the last twenty-four hours but was subsiding. The child had asthma of three days duration. No temperature elevation had been noted by the family. There was a history of recurrent diarrhea.

The physical examination was essentially negative except that the abdomen was distended and protruded. No masses were palpable.

Radiographic examination showed discrete linear



Fig. 4. Case II. Film taken immediately following admission of the child to the hospital with cramping abdominal pain. Linear densities in both the upper and lower small bowel.

densities in the small bowel (Fig. 4). A bronchopneumonia was found on chest examination.

Stool examination disclosed ova of *Ascaris lumbricoides*. Blood findings were: white cells 12,800, basophils 1, eosinophils 18, segmented forms 58, lymphocytes 22, mononuclears 1, hemoglobin 14 gm.

The child was treated with crystoids, following which he passed a large number of adult worms in a foul smelling stool. Recovery was uneventful.

ROENTGEN DIAGNOSIS

The radiographic visualization of adult *Ascaris* outlined by barium in the human intestinal tract was described by Fritz in 1924 (7). A short while later a similar case was reported by Schinz (16). Other reports followed, mainly in the European medical journals (21). A thorough study of the roentgen diagnosis of ascariasis was published by Archer and Peterson in 1930 (2). They called attention to two roentgenographic signs: (a) a cylindric filling defect in the jejunum and (b) a string-like shadow representing the barium-filled enteric canal of the parasite. Strang and Warrick (18) in 1948 enumerated two other

features, viz. linear shadows, due to adherence of barium to the worm, and evidence of disordered motility of the small bowel. The diagnostic value of these four criteria have been confirmed by others (5, 9, 13, 20, 22). Their elucidation is dependent on the use of a contrast medium.

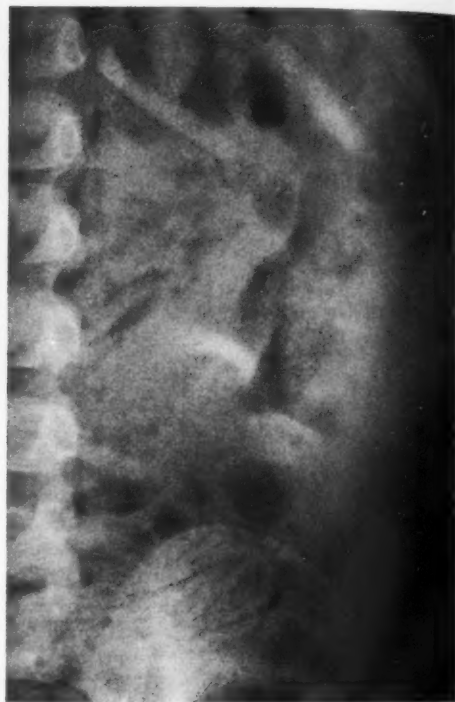


Fig. 5. Case II. Enlargement of the left mid-abdomen. The coiled mass of worms is well shown in the distal small bowel.

In the child with bowel distention due to a bolus of worms a diagnosis is at times possible by inspection of a plain film of the abdomen. The appearance of the worms in the distended small bowel was described by Skapinker in 1949 (17), and 2 cases were reported by Jenkins and Beach in 1954 (12). An excellent description of 3 cases was given by Isaacs in 1956 (11). The roentgen findings in one patient were described by Aiken and Dickman (1), and in this instance surgical resection was necessary for relief of obstruction. Since the segments of bowel obstructed by the parasites are distended with gas, the worms

appear as elongated, linear densities of uniform caliber (Figs. 1, 2, 4, 5). Visualization is possible because the worms are in contrast with the gas in the bowel. Isaacs aptly describes them as "appearing like a tangled group of thick cords." This can be readily appreciated in Figure 3.

TREATMENT

Once the diagnosis is established by stool study or radiographic examination, conservative medical treatment will usually effect a cure. Occasionally operative removal is necessary when medical means are unsuccessful or signs of perforation are present (1, 15, 19).

CONCLUSION

Migration of mature *Ascaris* within the intestinal tract of a child may cause bowel obstruction. The mass of worms within a distended segment of intestine can be identified on a plain film of the abdomen. In contrast to the air in the intestine the worms appear as linear densities of uniform caliber.

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SUMMARIO IN INTERLINGUA

Ileus A Ascarides In Juveniles

Le migration de ascarides matur intra le vias intestinal de un puero o puera pote causar obstruction del intestino. Si le causa de un tal obstruction non es recognoscite, illo pote esser sequite per necrose, perforation, peritonitis, e morte.

Le diagnose es suggerite per le identification del massa de vermes in un segmento distendite del intestinos in un simple radiographia del abdomine. Per contrasto con le aere in le intestino, le vermes es

visibile como densitates linear de calibre uniforme. Altere signos roentgenologic que es obtenibile per studios a contrasto es un cylindric defecto de replenation in le jejuno, un umbra filiforme que representa le barium in le canal enteric del parasito, umbras linear causate per le adhesion de barium al superficie del vermes, e indicios de un disordinate motilitate del intestino tenue.

Es reportate duo casos.

Premature Obliteration of the Sternal Sutures and Pigeon-Breast Deformity¹

GUIDO CURRARINO, M.D., and FREDERIC N. SILVERMAN, M.D.

THE PURPOSE of this paper is to illustrate an uncommon and little known developmental anomaly of the sternum characterized by premature obliteration of its sutures and by a tendency toward forward angulation. Associated with this angulation is an increase in the sagittal diameter of the thorax of the type seen in "arcuate pigeon breast."

CASE REPORTS

CASE I: A white male child had been under observation since birth for congenital micrognathia of mild degree, bilateral clubfoot, inguinal hernia, and cryptorchidism. A "pigeon-breast" deformity had also been present since early infancy. When last seen at four years, he appeared well developed, both physically and mentally; the deformity of the feet had improved considerably, the micrognathia only slightly. The child's head was elongated, but there was no roentgen evidence of premature cranio-



Figs. 1-3. Case I.

Fig. 1. Photograph of patient taken at four years. Note pigeon breast.

Fig. 2. Lateral roentgenogram of the chest taken at one year of age. The sternum is straight. The sternal sutures are irregularly spaced and abnormally narrow.

Fig. 3. Lateral roentgenogram of the chest taken at four years. The sternum is now angulated forward and consists of a solid bony plaque without any residue of sutures.

¹ From the Departments of Radiology and Pediatrics, College of Medicine, University of Cincinnati, The Children's Hospital, and The Children's Hospital Research Foundation, Cincinnati, Ohio. Accepted for publication in October 1957.

synostosis. The thorax showed a midline bulge, anteriorly (Fig. 1). The lateral roentgenograms of the chest taken at one and at four years are reproduced in Figures 2 and 3.

The father and mother were twenty-five and thirty years old, respectively, when the patient was born. They are living and well and show no thoracic deformity. Roentgenographically, the sternum of the father has a normal configuration and an open manubriosternal synchondrosis. The chest films of the mother reveal solid bony fusion of the manubriosternal junction. There are no siblings.

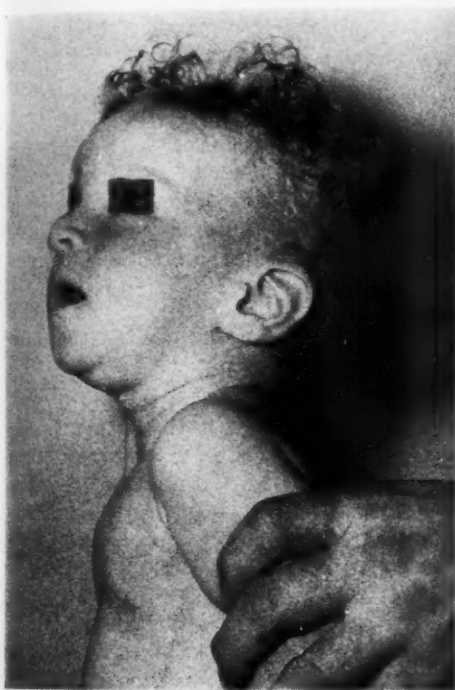


Fig. 4. Case II. Photograph of patient taken at six months of age. Note pigeon breast.

CASE II: A white female child was hospitalized for the first time at the age of six months. The chief complaints at that time were mild difficulty in swallowing, retarded physical development, asymmetry of the head, face, and eyes, and pigmented skin. On physical examination, the child appeared mentally alert but poorly nourished and underdeveloped; all the somatic measurements were below the third percentile. The skin was covered with white and brown blotches and streaks which were interpreted as manifestations of incontinentia pigmenti. There was an obvious flattening of the right occipital and left frontal regions. The left side of the face was smaller than the right. The left eye was small; the left pupil was cloudy and

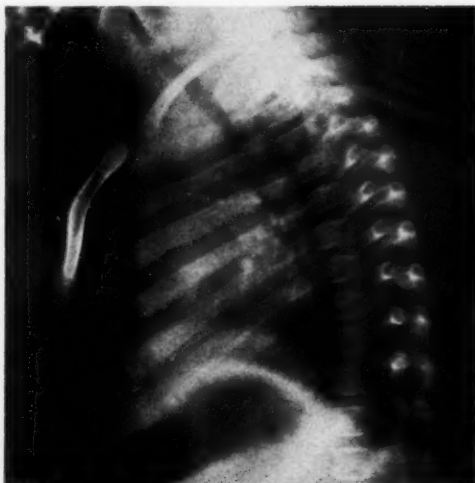


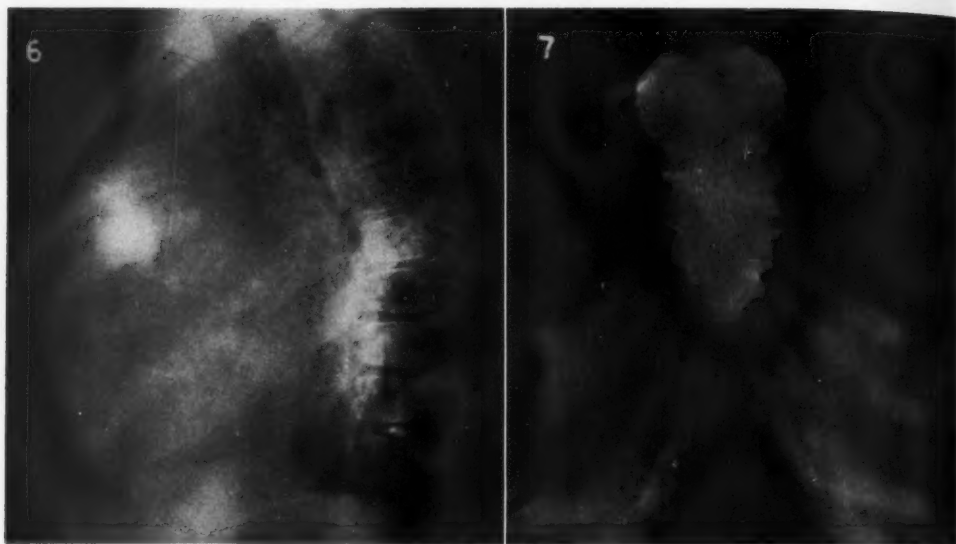
Fig. 5. Case II. Lateral roentgenogram of the chest taken at six months of age. The sternum is angulated forward and is entirely devoid of suture lines.

did not react to light. An ophthalmological examination showed microphthalmia and cataract on the left. The thorax showed a midline bulge anteriorly (Fig. 4). No gross abnormality could be recognized in the films of the skull and face. A barium swallow revealed a right aberrant subclavian artery crossing behind the esophagus. A lateral roentgenogram of the chest, taken at this time, is reproduced in Figure 5.

The swallowing difficulty subsided gradually. When re-examined at the age of one year, the child still appeared underdeveloped. All the other findings were the same as at the first admission. The hemogram, urinalysis, and multiple chemical studies of the blood serum showed no abnormality.

The father and mother were, respectively, thirty-three and twenty-three years old when the patient was born. They are both living and well and show no thoracic or other skeletal deformity. Roentgenographically, the sternum of the father is of normal shape, but shows an obliterated manubriosternal synchondrosis. The sternum of the mother is normal in shape, and has an open manubriosternal synchondrosis. In the remaining two children there is said to be no thoracic abnormality. A maternal aunt of the mother is reported to have an asymptomatic but rather severe deformity of the thorax, closely resembling that in the patient.

CASE III: A Negro male child was seen at regular intervals from the age of eight months to the time of death at thirteen years. The major symptoms and findings throughout life were poor physical development, exercise intolerance, atypical cardiac murmurs, electrocardiographic evidence of right ventricular hypertrophy, and roentgen signs of



Figs. 6 and 7. Case III.

Fig. 6. Lateral roentgenogram of the chest taken at seven years. The sternum is angulated and is entirely devoid of sutures. Note cardiomegaly and calcification of a nucleus pulposus in the low dorsal spine.

Fig. 7. Postmortem roentgenogram of the sternum, showing no residue of sutures. The obvious shortness of this sternum is thought to result from a decrease in the longitudinal growth which normally takes place at the suture lines.

cardiomegaly and gross pulmonary overcirculation. Both clinically and radiographically there was in addition a deformity of the anterior wall of the thorax, characterized by a pronounced midline bulge. This thoracic deformity was present from at least the eighth month of life and apparently increased in severity thereafter. No other obvious developmental anomalies were recorded.

At age thirteen, the patient was admitted in severe congestive failure, from which he did not recover. The cardiomegaly at that time was extreme. The main findings at autopsy were a large patent ductus arteriosus, a large ventricular septal defect, and pulmonary arterio- and arteriolar sclerosis. The lateral roentgenogram of the chest taken at seven years is reproduced in Figure 6. The roentgen appearance of the sternum at autopsy is illustrated in Figure 7.

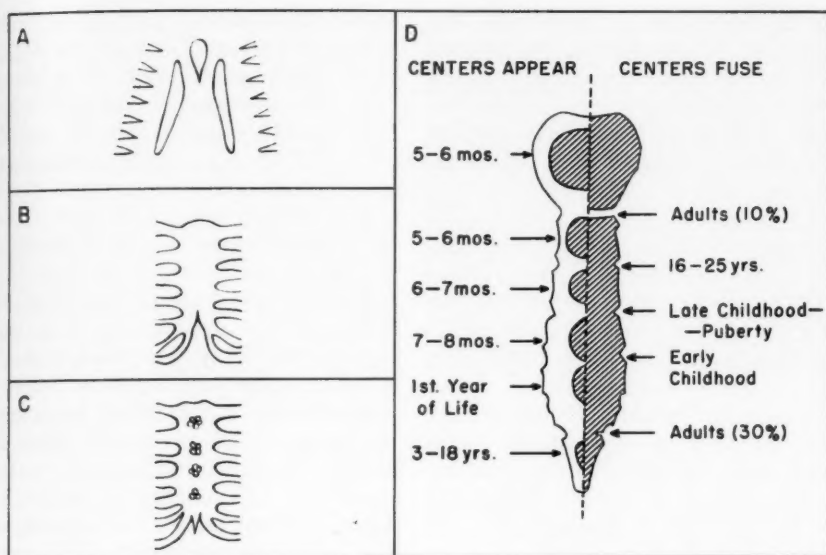
The father and mother were forty-three and forty-one years old respectively when the patient was born. The father is living and well; the mother died of carcinoma of the stomach at the age of fifty. No gross thoracic deformity is reported in the parents. There are six other children in the family; these are said to be well and free from visible skeletal malformations.

DISCUSSION

Figure 8 illustrates in diagrammatic form the main stages of the normal

development of the sternum and of its sutures. The data were obtained from several sources (1, 3, 5-8, 13, 16). The true sternum originates from 3 agglomerations of mesoblastic cellular tissue embedded in the chest wall: two lateral sternal bands, first visible at six weeks, and an anterior median rudiment, which appears slightly later. The sternal bands originate independently of the ribs; the medial element is embryologically related to the primordia of the shoulder girdle. As the embryo grows, the two sternal bands unite with the tips of the ribs, migrate forward with them, incorporate the median element, and finally fuse in the midventral line to form a single structure. Simultaneously, all the mesenchymal primordia are rapidly converted into cartilage. In the sternal bands, cartilage cells usually first appear laterally, between ribs, at the same levels where sternebrae will later develop. At nine weeks, the sternum is uniformly cartilaginous and resembles in shape the future bone,

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A—The Mesoblastic Primordia (2 Lateral Bands And A Median Rudiment)

B—Plate Of Hyaline Cartilage Originating From The Chondrification And Mid-Line Fusion Of The Primordia

C—Appearance Of Islands Of Hypertrophied Chondroblasts—The Future Ossification Centers

D—Ossification And Fusion Of The Various Sternebrae (Infant And Adult Sternum)

Fig. 8: Development of the sternum.

but it is still entirely unsegmented and still solidly united with the ribs. A definite segmentation into sternbrae is a late occurrence both in ontogeny and phylogeny.

Sternebrae are found only in some mammals and reptiles. In the rat, the earliest sign of segmentation is seen at sixteen days (3), when nuclei of hypertrophic chondroblasts (the primary areolae) make their appearance in the substance of the sternum, between pairs of ribs. These cellular islands are the precursors of the sternal ossification centers. This chondroblastic proliferation spreads centrifugally, but the various nuclei do not coalesce normally; they remain separated from each other, at the levels of the costochondral junctions, by bands of small-

celled or resting cartilage, which represent the future sternal sutures. In man, the sequence of events is the same, but the time of appearance of the primary areolae could not be determined from the material reviewed.

Little is known about the special factors which determine the location of the various ossification centers and the adjacent sutures and about the factors which delay the maturation and ossification of the tissue forming the suture lines. It is commonly stated that segmentation is a secondary acquisition, not controlled by factors present in the primordia. According to Paterson (13), bone production in the sternum may be excited by stress or strain affecting particular points in the cartilaginous mass, causing vasculariza-

tion and ossification. Hanson (8) has suggested that sutures develop in response to stress at certain structurally weak points in the fetal sternum, where this structure is narrowed by the notches normally present at the costosternal junctions. According to a more recent view, (3, 4) the ribs are directly responsible for the formation of the sutures and consequently for the location of the various ossification centers. The tips of the ribs are said to inhibit the spread of the chondroblastic proliferation to the adjacent cartilage of the sternum, with the result that this cartilage remains immature and therefore resistant to ossification. This inhibitory effect, which may be mechanical and/or biochemical in nature, is thought to be exerted only if intimate contact exists between ribs and sternum.

The average time at which the various segments of the sternum begin to ossify, and the ages at which they fuse with each other, are also outlined in Figure 8. Multiple ossification centers for each sternebra, especially in the gladiolus, are not uncommon. Ossification of the centers for the manubrium and for the proximal three segments of the mesosternum starts during the last three or four months of fetal life; the distal segment of the mesosternum and the xyphoid process ossify after birth.

The xyphoid process may remain cartilaginous throughout life. Bony union among the four segments of the mesosternum occurs usually from below upward, starting in early childhood; it is said to be complete between the sixteenth and the twenty-fifth year of life. Fusion of the gladiolus with the xyphoid is found in approximately 30 per cent of individuals after the second decade. The manubriosternal synchondrosis, when not affected by acquired diseases, remains open throughout life in the majority of instances; in approximately 10 per cent of normal sterna it ossifies spontaneously. The incidence of such spontaneous obliteration with advancing age is reported by Ashley (2) to be as follows:

0-9 years.....	0%
10-19 years.....	1.8%
20-29 years.....	5.4%
30-39 years.....	9.3%
40-49 years.....	11.5%
50-59 years.....	10.6%
60-69 years.....	10.6%
70-79 years.....	12.7%
80-89 years.....	7.9%

According to Ashley, this physiological fusion of the manubrium with the first segment of the mesosternum takes place only in sterna in which in fetal life a fibrous lamina has failed to develop at this level. Such fibrous structure is considered to be the precursor of the synchondrosis. Two fibrous laminae can be found in fetal sterna: a superior, at the site of the future manubriosternal synchondrosis, and an inferior, at the junction between the mesosternum and the xyphoid process. These fibrous laminae are already present in most instances during the third fetal month; in the newborn, the manubriosternal junction is fibrous instead of cartilaginous in approximately 75 per cent of cases, whereas the junction between the mesosternum and xyphoid is fibrous in only approximately 30 per cent (13). Very rarely the superior lamina (and consequently the future manubriosternal synchondrosis) is at the level of the third pair of ribs instead of at the second (hylobatian or simian sternum). Congenital fusion of the manubrium with the first segment of the gladiolus also occurs very seldom (2).

Several other developmental anomalies of the sternum have been described, some of which are well known. Most of them can be explained on the basis of an arrest of development at one of the various embryological stages mentioned above. The present discussion is limited to defective segmentation. Complete nonsegmentation or premature synostosis of all the sternal segments is apparently uncommon. Only one such instance in man could be found in the available literature; this was observed by Monnet *et al.* (12) in

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an infant with cyanotic congenital heart disease. The reproduction of the lateral film of the chest, taken when this patient was one month old, clearly shows that the ossified part of the sternum was entirely unsegmented and angulated forward. The autopsy, performed at the age of five months, showed transposition of the aorta, a small interventricular septal defect, and partial anomalous return of the pulmonary veins. Herdner (9), in a paper dealing with developmental anomalies of the sternum in childhood, mentions having encountered a solidly fused sternum in a seven-year-old child and makes the suggestion that such malformation may be responsible for certain thoracic deformities seen in adult life.

Nonsegmentation of the sternum has been found, among other anomalies, in a recessive mutation of mice called "screw-tail," obtained from brother and sister inbreeding of the CBH-Bagg albino strain (3, 11). In the screw-tail mouse the sternum is wide, short, and undivided, and the ribs are crowded together at their junction with it. The xiphoid process originates from a separate center, but fusion of this center with the rest of the sternum occurs early, frequently before birth. According to Bryson (3), the failure of segmentation and widening of the sternum in this animal are due to a poor contact between the ribs and the sternum, a finding which he could demonstrate both in the embryo and the adult. This inadequate contact is thought to result from a decreased longitudinal growth of the ribs; the absence of sternal sutures is said to be responsible for the decreased longitudinal growth of the sternum and the crowding of the ribs. An unsegmented sternum has also been noted by Warkany (15) in a certain percentage of offspring of rats reared on a deficient diet.

The 3 patients described in this paper showed a solidly synostosed sternum at an abnormally early age. In Cases II and III the anomaly was already present in the first available roentgenograms of the chest taken at the age of six months

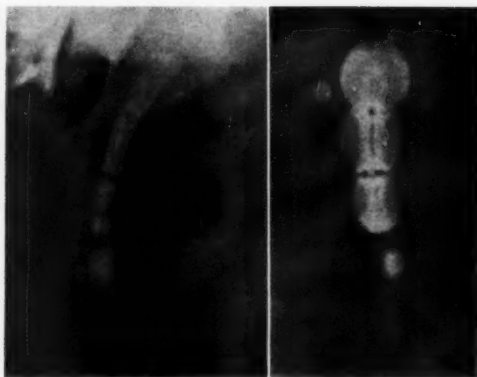


Fig. 9. Three-day-old white female infant with atresia of the esophagus and tracheoesophageal fistula.

A. Lateral roentgenogram of the chest showing slight anterior bowing of the sternum and narrow sternal sutures.

B. Postmortem roentgenogram of the sternum showing partial obliteration of sternal sutures.

and seven years respectively. Neither in these 2 instances, nor in the one-month-old infant described by Monnet, is it possible to state whether the sternum originated from a single ossification center (complete failure of segmentation), or whether the various sternal nuclei fused prematurely (incomplete segmentation, premature fusion). In Case I, we are apparently dealing with premature synostosis, becoming complete between six months and four years. The first film of the chest, taken when the patient was six months old, showed residual suture lines across the sternum. These radiolucent lines were very narrow and irregularly spaced. Narrowing of the sternal sutures of such degree is not seen in normal infants. If an analogy with the cranial sutures of some infants affected with craniostenosis is possible, such narrowing may reflect a faulty development of the sutures, an inherent tendency toward premature obliteration, and presumably, also, the presence of partial bony bridging.

In addition to the synostosis, the sternum in each of these 3 infants showed a forward angulation in the middle third or proximal half. At the site of this angulation, there was a midline protrusion of the anterior chest wall and a localized increase in the

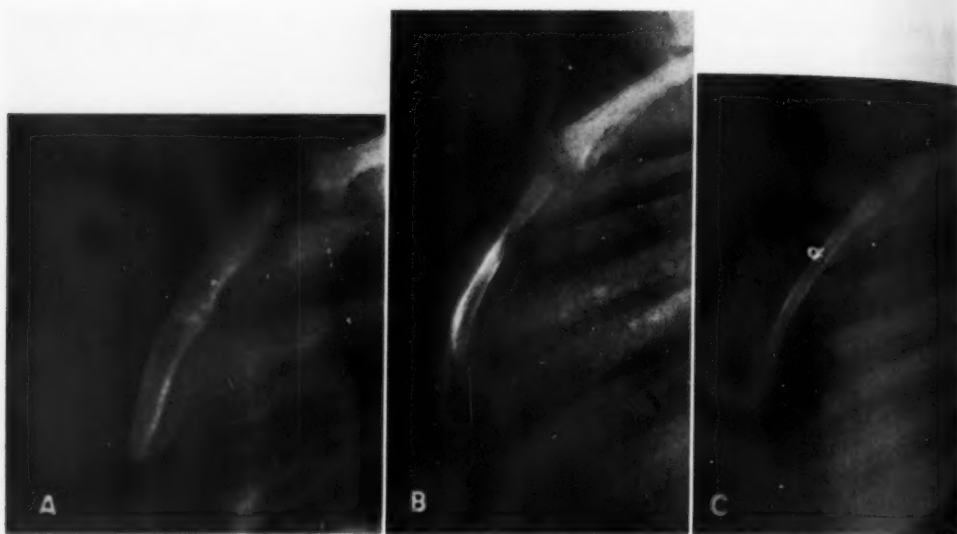


Fig. 10. Three sterna showing a slight forward bowing, a diminished number of sutures, and an almost complete obliteration of the sutures which are still present.

A. Four-month-old white male hospitalized for congenital laryngeal stridor. The sternum of the father has an open manubriosternal synchondrosis; that of the mother shows a fused manubriosternal junction.

B and C. N. S. and M. S., white female twins aged eight months. They resemble each other closely but they are not identical; each has a dolichocephalic skull, a slightly beaked nose, a slightly underdeveloped mandible, large ears, and a very mild pigeon breast. M. S., in addition, shows signs of patency of the ductus arteriosus. No thoracic deformity is present in the parents or in an older sibling. The sternum of the father has an open manubriosternal synchondrosis. The manubriosternal synchondrosis in the mother is almost completely obliterated.

sagittal diameter of the thorax. The sagittal diameter of the thorax at the level of the lower third of the sternum was not appreciably altered. This deformity resembles the "arcuate" type of pigeon breast of Lester's classification (10). The sternal angulation may be an associated anomaly secondary to other causes, but the fact that, at least in Case I, it developed *pari passu* with the synostosis, suggests a cause-and-effect relationship between these two factors. Whether the ribs played any part in the development of the premature fusion or failure of segmentation of the sternum and in its angulation is not known. Radiographically, there were no signs of costal malformations.

Congenital nonsegmentation of the sternum or premature obliteration of all its sutures, to our knowledge, has not previously been incriminated as one of the possible causes of pigeon breast. A definite history of progression of the sternal kyphosis and of the pigeon breast de-

formity was obtained in only 1 patient (Case III). In the others the lapse of time is obviously too short to indicate, as yet, what the end-result may be. Should a severe pigeon breast deformity be the uniform end-result in all such instances, the advisability of early operative intervention, when the structures are still soft, as advocated by Ravitch (14), may have to be considered. The association of nonsegmentation of the sternum with other congenital malformations is of considerable interest, but we are not prepared to evaluate its significance. It may be that the abnormal sternum is an expression of an abnormality of development that affects other organ systems in the body as well.

ADDENDUM

In Figures 9, 10, and 11 are reproduced the roentgenograms of 7 additional sterna, which are thought to be affected by the anomaly under consideration—the first 4 in an early phase, the remainder presumably in an incomplete form. Brief clinical histories are given in the legends.

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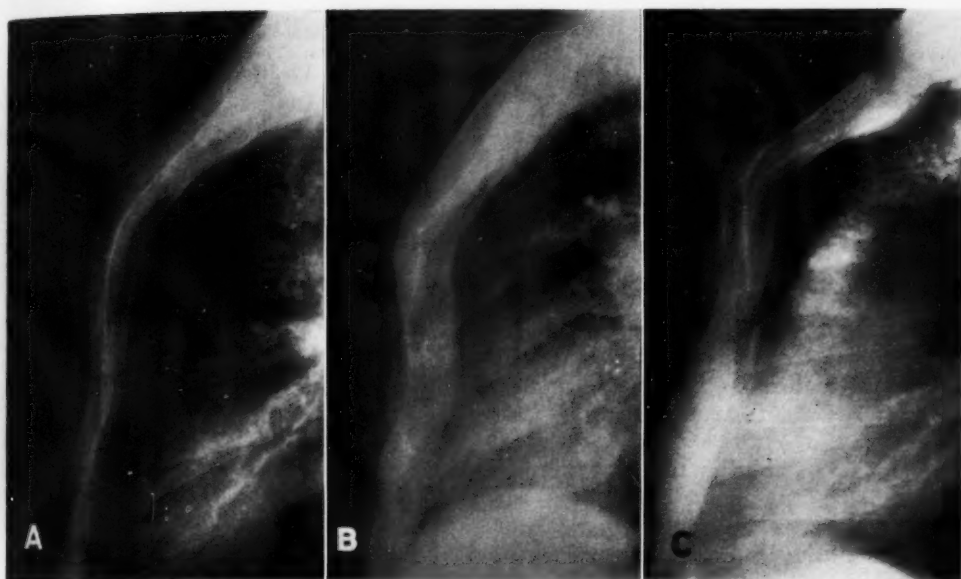


Fig. 11. Three sterna showing a pronounced kyphosis and complete obliteration of all the sutures except for an extremely narrow radiolucent line at the manubriosternal junction, visible only in special oblique roentgen views of the chest.

A. Seventeen-year-old white female with symptomatic congenital heart disease, diagnosed as patency of the ductus arteriosus associated with pulmonary artery hypertension. She was physically and mentally retarded. Her facial appearance was unusual ("hypotelorism," low-set ears, large forehead, prognathism, defectively developed dentition, and high arched palate). There was, in addition, a marked pigeon breast, which had been present since infancy. No thoracic or other deformities were reported in the parents or siblings.

B. Thirteen-year-old white male affected with symptomatic congenital heart disease of the cyanotic group, diagnosed as ventricular septal defect with pulmonary artery hypertension. A marked pigeon breast had been present since at least early childhood. No information is available on parents or siblings.

C. Eleven-year-old white male hospitalized for mild "idiopathic" scoliosis and marked pigeon breast. The pigeon breast had probably increased slightly since infancy. No other congenital anomalies were present. The father is said to have a marked but apparently asymptomatic pigeon breast. The mother has a closed manubriosternal junction. The sterna of 3 siblings are normal roentgenographically except for a mild pigeon breast in one.

The sternum of Figure 9 is that of a newborn; it showed narrowed but apparently still open sutures. Bony bridging was obvious only in the postmortem specimen. Histological sections of the sutures confirmed the abnormal narrowing and the bridging but failed to show any appreciable abnormality in the cartilage substance which was still present within the sutures. No fibrous laminae could be identified anywhere in this sternum. Had this patient lived, solid synostosis undoubtedly would have taken place prematurely.

Premature synostosis of the various segments is likewise expected to occur in the three sterna of Figure 10, which are from infants still under one year of age. These sterna show a diminished number of sutures, a marked narrowing of those present and, almost certainly, bony bridging within them. In all 4 instances, there is already a tendency toward an anterior sternal bowing, but this deformity is much more marked in the last 3 sterna of the group (Fig. 11), which belong to older patients. Clinically, in these 3 instances there was a severe

pigeon breast of the "arcuate" type. Roentgenographically, in addition to the angulation, there is absence of all the sutures or of any residue of such, except for an extremely narrow radiolucent line at the manubriosternal junction, identifiable only in special oblique projections.

It is worthy of note that 3 of the patients included in the above Addendum and 2 of those for whom case reports are given showed also evidence of a congenital cardiovascular malformation consisting mainly in a shunt associated with signs of peripheral pulmonary artery disease. Also of interest is the high incidence of obliteration of the manubriosternal synchondrosis in the parents who were examined roentgenographically. Whether this finding has any genetic implication in respect to the nature of the sternal anomaly in

the children is not known at the present time.

SUMMARY

Three cases of a little known and apparently uncommon developmental anomaly of the sternum are reported. This anomaly, consisting of obliteration of all the sternal sutures at an abnormally early age, is thought to be the result of inadequate segmentation of the sternum during fetal life and consequently of poorly formed suture lines, which tend to ossify prematurely. Complete nonsegmentation cannot be excluded in some instances. In addition to the synostosis and probably secondary to it, the sternum shows a forward angulation with a corresponding increase in the sagittal diameter of the thorax (arcuate pigeon breast).

The normal development of the sternum and the available literature concerning the anomaly are reviewed. Seven additional cases, probably of the same disorder in an early phase or in an incomplete form, are also illustrated.

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SUMMARIO IN INTERLINGUA

Obliteration Del Sutura Sternal E Deformitate De Pectore Gallinate

Es reportate tres casos de un pauco cognoscite e apparentemente incommun anormalitate disveloppamental del sterno. Iste anormalitate consiste del obliteration de omne suturas sternal a un etate anormalmente juvene, e illo es interpretate como le resultado de un inadequate segmentation del sterno durante le vita fetal e de un consequentemente insufficiente formation del lineas de sutura que alora tende a ossificar se prematurmente. In certe casos, un absentia complete del segmentation debe

esser considerate como possibile. In ultra del synostosis, e probabilemente secundari a illo, le sterno monstra un angulation in avanti e un augmento correspondent in le diametro sagittal del thorace (arcuate thorace gallinate).

Es presentate un revista del disveloppamento normal del sterno e del litteratura concernente le anormalitate in question. Septe casos additional de probabilemente le mesme disordine in un forma precoce o incomplete es etiam illustrate.

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The Comparative Biological Response of Dogs to 250-kvp and 100-kvp X-Rays¹

E. L. ALPEN, D. M. JONES, H. H. HECHTER, and V. P. BOND

J. W. BOAG (1), in reviewing the subject of relative biological efficiency of ionizing radiations, has approached the problem of energy transfer in tissue by arbitrarily classifying the energy absorption pattern as: (a) macroscopic and (b) microscopic. By the former is implied the distribution of energy absorption normally represented by "isodose surfaces" or depth-dose curves of a particular radiation beam. The latter refers to the distribution of discrete ionizing events along the paths of the ionizing particles. This microscopic distribution of energy has been represented by Zirkle (2) and others in terms of the quantity linear energy transfer (LET). In the comparison of various types of radiation therapy, these two effects should be treated separately to arrive at an understanding of the relative biological effectiveness (RBE).

When one compares x-rays of energies in the range of 100 to 250 kvp, the changes in specific ionization or LET are not significant. For this reason the problem of depth dose effects can be considered without significant interaction from LET effects. Energy and geometry factors should enter only in so far as they contribute to determining the pattern of dose deposition or depth-dose curves. This report will compare 100-kvp and 250-kvp x-rays and attempt to establish the relative effectiveness under conditions in which the distributions of dose throughout the animal are as uniform as is possible with the two radiation qualities employed.

METHODS

Mongrel dogs weighing initially between 7 and 15 kg. were used in all experiments. All animals were kept in isolated receiving

runs for a minimum two-week quarantine period before use. During this interval they were dewormed and immunized for distemper and hepatitis. Animals were transferred to individual cages in temperature-controlled animal rooms two weeks before exposure.

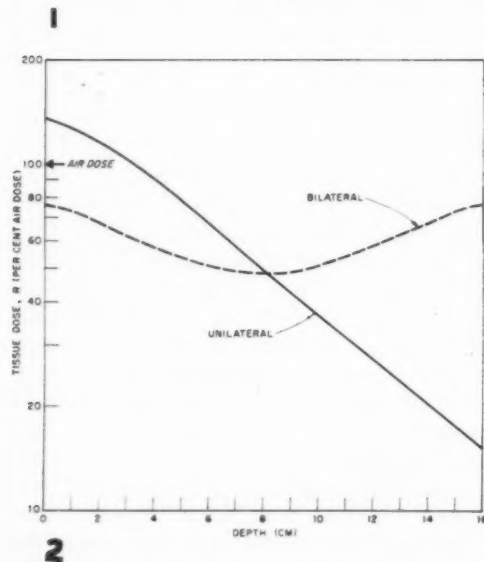
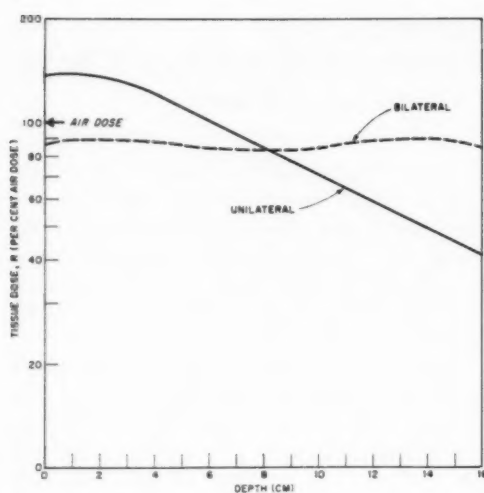
Ten days before irradiation, sampling for blood studies was begun, a total of five samples, one every other day during the pre-irradiation period, being obtained for each dog. The values obtained during this period were pooled for each animal and the average taken as the pre-exposure value in that instance. Any animal showing signs of illness in the hemogram findings, failure to eat, or signs of respiratory infection was excluded from the study.

Blood samples were obtained by venipuncture of either external jugular vein and withdrawal into a clean 5-ml. syringe equipped with sterile needle. All syringes and blood pipettes used were siliconized. After each sample was withdrawn, the needle was removed from the syringe, about 1 c.c. was expelled onto a siliconized watch glass to be used for cell counts, 1 c.c. was expelled into each of two siliconized 13 × 100-mm. Pyrex tubes, which were placed in a water bath at 37° C. to be used for a two-tube Lee-White clotting time, and the remainder was discharged into an oxalated glass vial for the hematocrit determination. Blood studies were performed on days 1, 3, 7, 11, 15, 21, 24, and 30 post-irradiation as well as before exposure.

Standard Thoma pipettes were used for white-cell, red-cell, and platelet counts. White cells were counted in standard Neubauer hemocytometers. Red cells were counted by the light-scattering photo-

¹ From the U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.; Yale University School of Medicine (D. M. J.); Brookhaven National Laboratory (V. P. B.). Accepted for publication in October 1957.

The opinions or assertions contained herein are those of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Establishment at large.



Figs. 1 and 2. Tissue distribution of dose for 250-kvp x-rays (Fig. 1) and for 100-kvp x-rays (Fig. 2).

metric technic (3). Platelets were counted in selected hemocytometers on a phase contrast microscope according to the method of Brecher and Cronkite (4). All samples were pipetted in duplicate and both chambers of a hemocytometer counted for each pipette. Pipettes were rotated ten minutes before filling the chambers and filled chambers were allowed to settle ten minutes before counting. The modi-

fied Lee-White clotting time method has been described in a previous paper (5). Hematocrits were determined by Wintrobe hematocrit tubes spun at 3,000 r.p.m. for thirty minutes in an International size 2 centrifuge.

The animals were irradiated with a Westinghouse therapy unit. At 250 kvp the added filter was 0.5 mm. Cu and 1.0 mm. Al, the current was 15 ma, the target-skin distance was 79 inches, the dose rate was 6.3 r/min., h.v.l. 1.5 mm. Cu. For the 100-kvp radiation no additional filter was used other than that inherent in the tube, the current was 15 ma, the target-skin distance was 50 inches, the dose rate was 6.2 r/min., h.v.l. 4.0 mm. Al. Dose rates were measured in air with a 25-r Bakelite Victoreen chamber at the midline position of the animal. The animals were anesthetized with pentobarbital sodium, 30 mg./kg. given intravenously, immediately prior to irradiation. They were suspended in a horizontal position in canvas slings during irradiation. One-half of the total dose was given to each side.

For hematological studies a replication consisted of 8 dogs, with 1 animal represented at each of the following dose levels: 260, 280, 300 and 320 r for 250 kvp, and 600, 650, 700, and 750 r for 100 kvp. A total of four replications were made, spaced at two-week intervals. The dose schedule for the mortality studies is shown in Table I.

Depth dose determinations were made in water-filled Lucite phantoms with Bake-

TABLE I: DOSE-RESPONSE STATISTICS FOR DOGS EXPOSED TO 250-KVP AND 100-KVP X-RAYS

250 kvp			100 kvp		
Dose (r)	Died/Total	Response (%)	Dose (r)	Died/Total	Response (%)
200	0/4	0	450	0/1	0
250	0/5	0	550	1/11	9
260	4/12	33	600	6/17	35
275	8/20	40	650	7/17	41
280	4/7	57	670	1/1	100
285	4/8	50	675	5/6	83
300	12/16	75	700	6/12	50
320	3/4	75	723	0/1	0
350	5/5	100	750	7/9	77
400	4/4	100	775	1/1	100

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lite ionization chambers.² The Lucite phantom measured 16 × 30 cm. and was 25 cm. high. The radiation beam was parallel to the 16 cm. dimension. Bilateral exposure depth dose curves were measured directly with an equally divided exposure.

RESULTS

Table II presents the estimates of the LD 50 and slope of the probit regression line (log dose) as calculated by the method of maximum likelihood (6).

TABLE II: ESTIMATES OF PARAMETERS OF THE DOSE-RESPONSE RELATIONSHIP OF DOGS EXPOSED TO 100-KVP OR 250-KVP X-RAYS

Parameter	Beam Energy*		Test of Significance (p)
	100 kvp	250 kvp	
LD 50:			
Air dose (midline)	664(±20)r	281(±5)r	p < 0.01
Surface dose	505(±15)	234(±5)	p < 0.01
Tissue dose (midline)	316(±13)	228(±4)	p < 0.01
Slope (b)	12.2(±4)	19.5(±5)	(n.s.)

* ± standard error of estimate in parentheses.

The median lethal air dose of 100-kvp x-rays is approximately twice the dose required for the same effect when exposure is made with 250-kvp x-rays. Water phantom measurements of the volume distribution of dose for the two qualities of radiation are represented in Figures 1 and 2. The bilateral exposure curve represents the dose distribution for the experiment reported here. No type of dose measurement considered affords an adequate prediction of mortality independent of energy considerations. The dose to the median sagittal tissue plane approaches this criterion most closely, but still is not completely satisfactory.

The slope of the probit regression lines, 12.2 and 19.5 for 100 and 250 kvp, respectively, are not significantly different.

As seen in Table III, no significant differences in mean survival time are found between the two treatments. The pooled estimate of survival time, 16.4

TABLE III: SURVIVAL TIME OF DECEDENTS FOR DOGS IRRADIATED WITH 100-KVP AND 250-KVP X-RAYS

250 kvp		100 kvp	
Dose	Mean Survival Time (days)	Dose	Mean Survival Time (days)
260	13.0	600	25.0
280	15.7	650	15.0
300	18.6	700	12.0
320	17.8	750	16.5
Mean	16.2 ± 4.8	Mean	17.1 ± 5

Pooled mean survival time 16.4 ± 4.3 days.

days, corresponds closely to that observed by others in irradiated dogs (7, 8).

Gross pathology is also essentially the same in all groups. Survivors showed few outward signs of illness other than a moderate weight loss. Dying animals had diarrhea starting on the third to the fifth postirradiation day. Nasopharyngeal edema and infection were frequently seen in decedents about the tenth to the fifteenth day. These were accompanied by rectal and buccal hemorrhage and subcutaneous purpura. The most outstanding and consistent pathologic findings at necropsy were severe pneumonitis and hemorrhage into all organs.

The hemograms for dogs receiving radiation of either quality are shown in Figures 3 to 7. Observations on decedents are separated from those on survivors. With either radiation both the total leukocyte counts and platelet counts were at the point of maximum depression on day 11 to day 15. In each case these points of maximum depression were very near zero. Because of the dilution factor of 2,500, platelet counts below 10,000/μl are of little significance. It is interesting, however, that even at these low platelet levels the Lee-White clotting time was still finite, though prolonged. Response of red cells at these doses was less pronounced, as has been previously observed by many others. In general, however, the decline was much more prolonged, and in the interval studied there was no evidence of a return to normal.

No significant differences in response to radiation of either quality can be observed on the basis of doses producing

² Landsverk Electrometer Co. Model L-50.

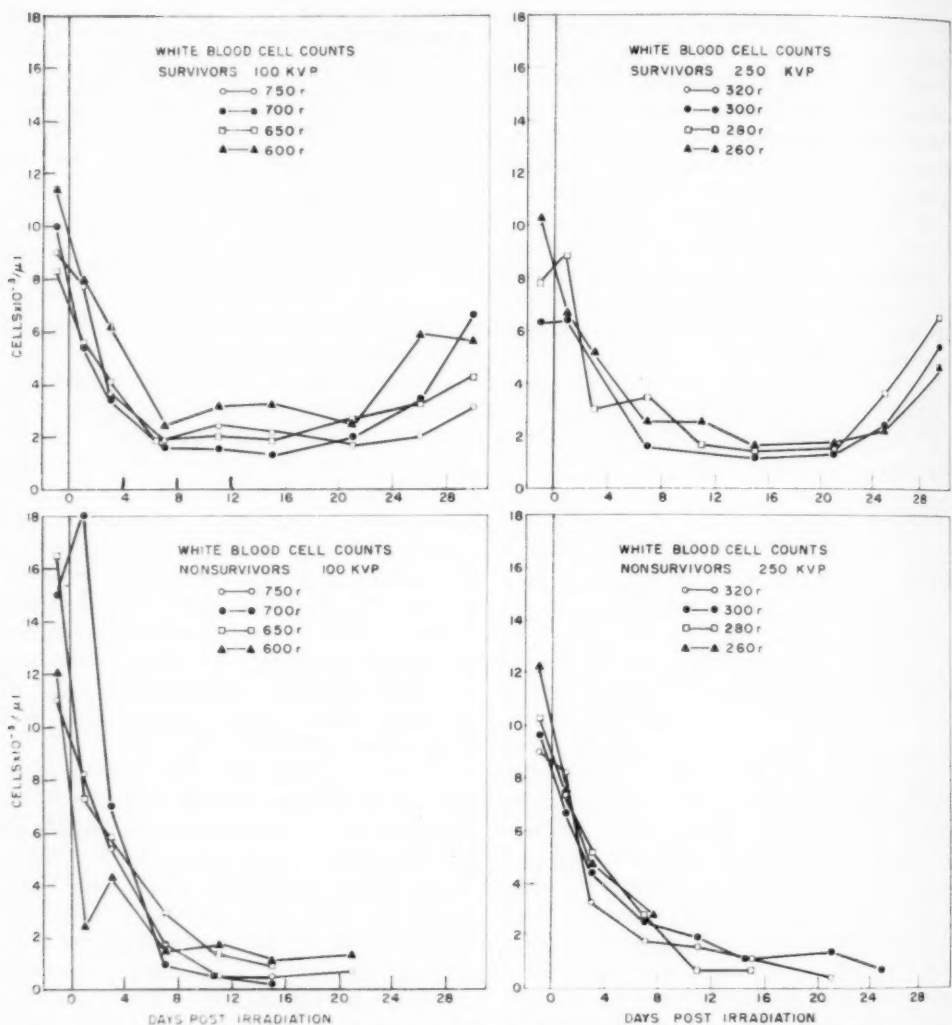


Fig. 3. Serial peripheral total white counts for 250-kvp and 100-kvp irradiated dogs.

equal mortality. Nor was it possible to establish a dose-response relationship for the end-points studied. This latter finding, of course, is related to the close spacing of dose levels required for the dose-mortality response. The decedents generally exhibited more profound responses than survivors but this difference is within the statistical variability experienced.

DISCUSSION

There have been several previous attempts to establish a single statement of

dose that expresses adequately the relative effectiveness of various qualities and types of ionizing radiation. Potter (9) has stated that for rats a good correlation exists between exit dose and lethality for 100- and 400-kvp x-rays. Ellinger (10) has also proposed the exit dose for a dose parameter, using 140- and 250-kvp x-rays in mice. In neither case was any residual difference in the "effective" dose, expressed as exit dose, seen for the different energies. As an alternative it has been suggested, particularly for bilateral or

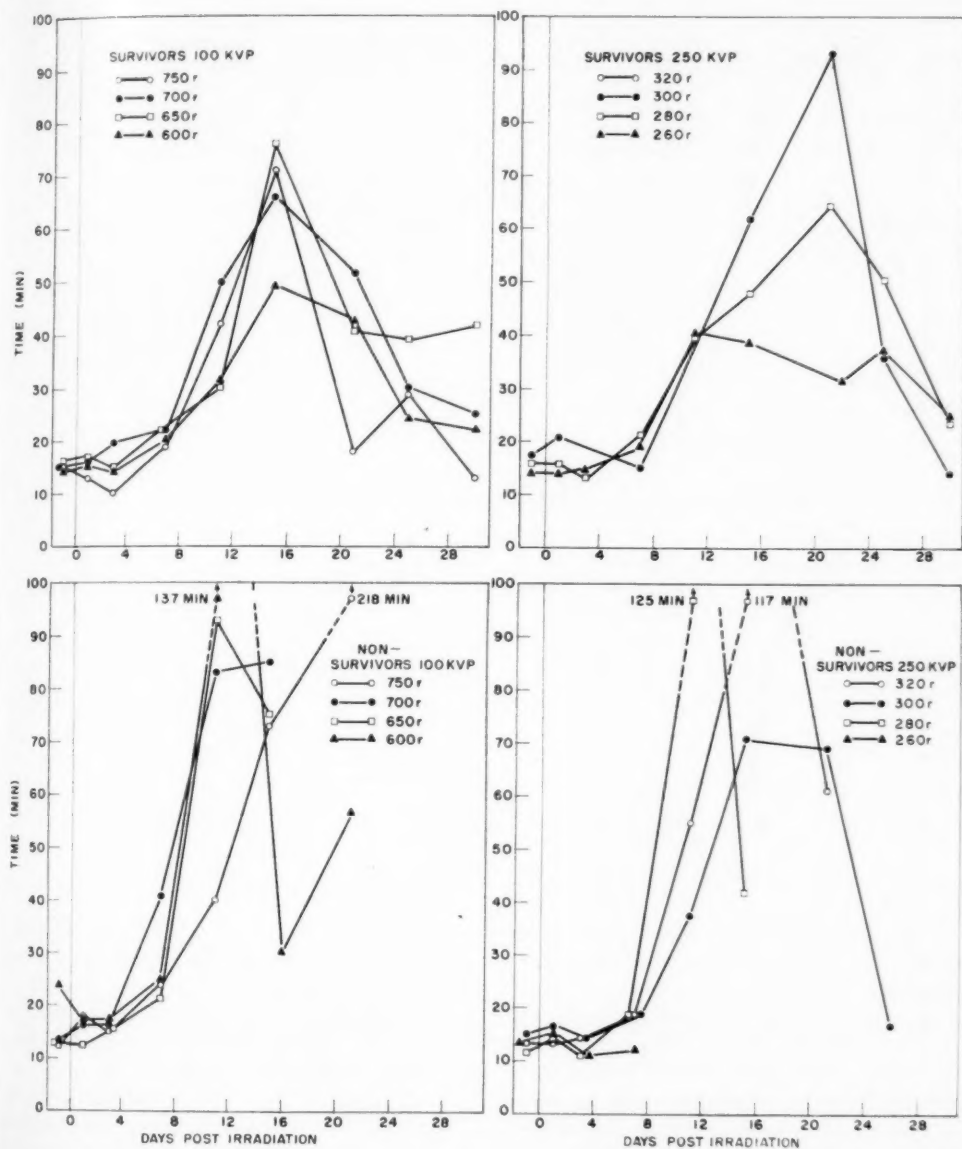


Fig. 4. Serial measurements of Lee-White clotting time on 250-kvp and 100-kvp irradiated dogs.

multiport exposure of larger mammals (7), where exit doses are equal to the entrance dose and essentially uniform distribution of dose through the animal is achieved, that midline tissue dose may be utilized as the best single parameter to estimate biological effect. With dose expressed as midline tissue dose, the LD 50 for the dog

is independent of energy over the range of 250 to 2,000 kvp (7).

With lower energies, or with larger animals, where even with bilateral exposure it is not possible to obtain uniform distribution of dose, the midline tissue dose does not normalize the LD 50 values for different energy radiations. This is

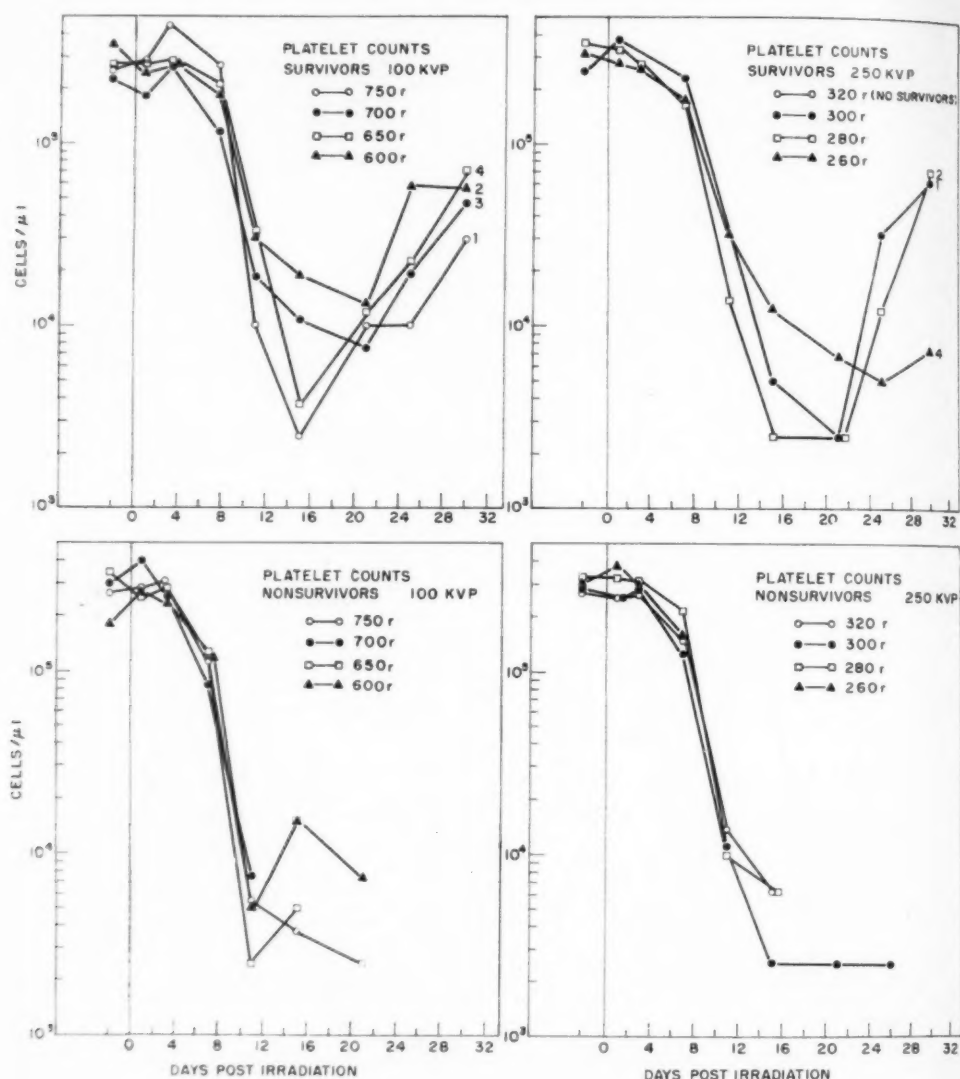


Fig. 5. Serial platelet counts for 250-kvp and 100-kvp irradiated dogs.

seen with the energies used in the present work with dogs and has been noted previously by Grahn, Sacher, and Walton for lower energies in mice and rabbits (11).

Efforts have been made toward other practical approaches to the problem of energy dependence in the field of radiologic safety. Such doses as the 1-cm., 3-cm., 5-cm., and 7-cm. depth dose in tissue-equivalent materials have been sug-

gested for this purpose. None of these expressions, which make use of the dose reduction concept, completely satisfies the requirement of correlation of biological effectiveness with physical dose over a wide range of energies. For the data presented here, however, the tissue dose measured at the midline tissue plane more nearly approaches the ideal.

Grahn *et al.* have substituted and in-

corporated an alternative "conservative" submission on dose energy sumes with a regard to use tenable parallel for the association of the real biological an

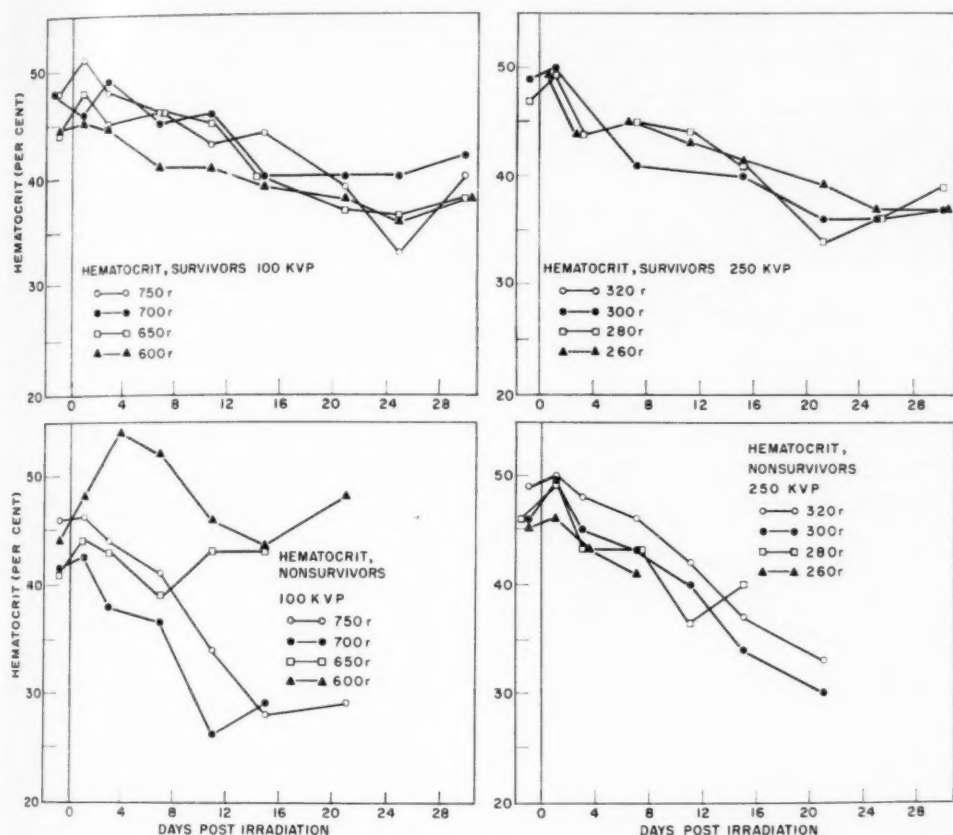


Fig. 6. Serial hematocrit determinations on 250-kvp and 100-kvp irradiated dogs.

incorporated with the dose reduction method an alternative technic called by them the "constant slope hypothesis." This is submitted as a means of arriving at a single regression equation for mortality on dose that would be independent of energy considerations. This method assumes that a unique slope is associated with all mortality curves for a given species regardless of radiation quality. It seems to us that the constant slope concept is tenable only in those experimental situations where evidence is presented for this parallelism. This situation does not hold for the data presented by Grahn and his associates in their report. If the slope of the dose-mortality regression line has real biological meaning, efforts to impose an average slope when significant slope

differences exist is not a useful technic.

Probably the most suitable answer to the problem of relative biological effectiveness lies in the elaboration of the concepts which have been suggested repeatedly by many investigators. When a specific biological system is under independent investigation without influence of abscopal effects, it may be possible to outline a model, such as the LET hypothesis, that will satisfactorily interrelate such variables as ionization density, energy, and energy absorption distributions. A close approximation to this ideal might be achieved if the system under study here were evaluated in terms of specific organ dose in rads or rep and the response of that organ. For example, direct measurement of radiation dose in bone marrow might distinctly improve on

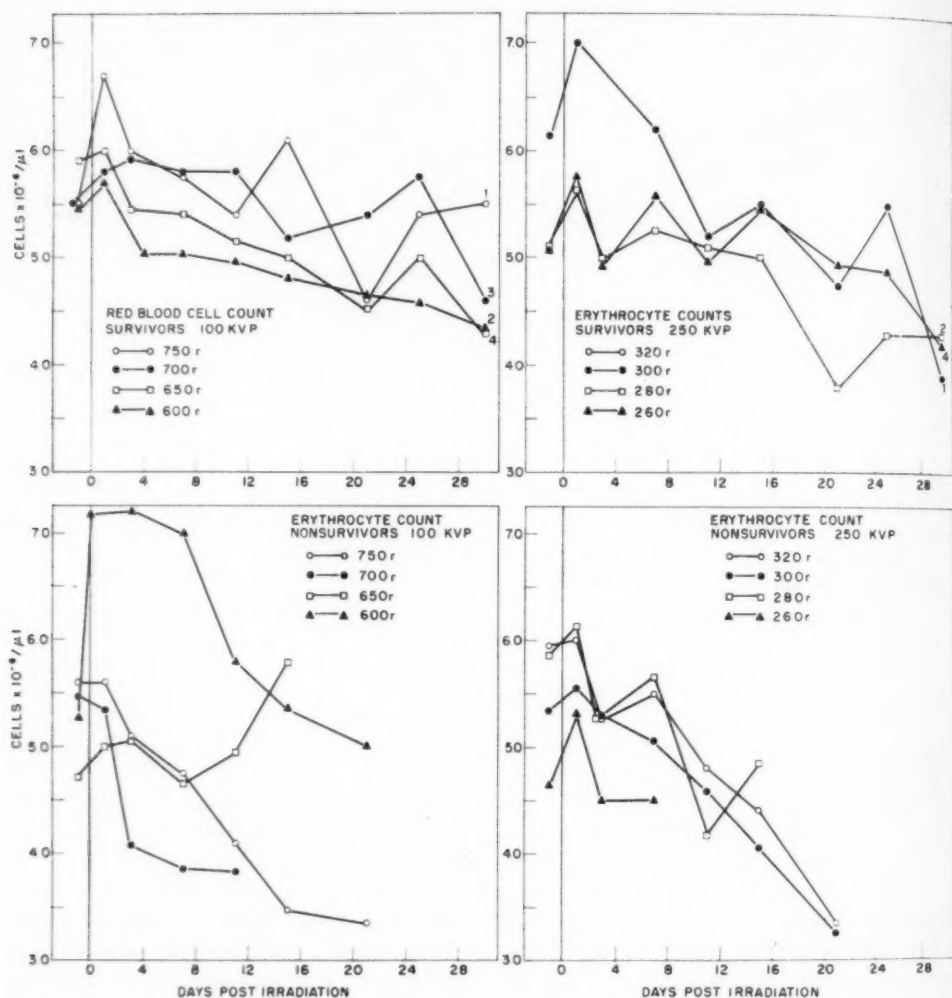


Fig. 7. Serial erythrocyte counts on 250-kvp and 100-kvp irradiated dogs.

the measurement of mortality response in the clearly inhomogeneous organ system of the intact animal. Local organ doses may vary appreciably as a result of local shielding conditions: particularly, bone may provide an appreciable degree of shielding or actually potentiate the marrow dose, depending upon the energy of the incident radiation, as shown by Spiers (12, 13), and Wilson (14). An ideal system of "weighted organ integral dose," where specific organ doses weighted properly for their biological contribution to the biological response

concerned and integrated over all organ volumes, has also been suggested. It seems, however, that in the intact large mammals studied here, large weighting factors for bone marrow dose would essentially reduce this to the simpler system of bone marrow dose alone.

SUMMARY

Mongrel dogs were exposed to graded doses of 100-kvp and 250-kvp x-rays, and the LD 50 was calculated for each treatment. In terms of midline air dose, these

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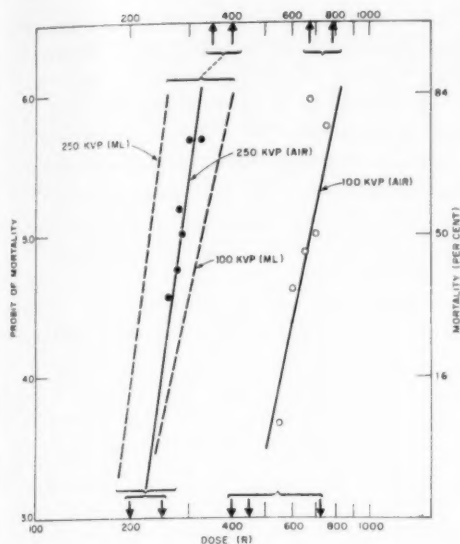


Fig. 8. Probit regression lines for 250-kvp and 100-kvp irradiated dogs (log dose).

values are: 100 kvp, $664 \text{ r} \pm 20 \text{ r}$; 250 kvp, $281 \text{ r} \pm 5 \text{ r}$. The midline tissue doses are $316 \text{ r} \pm 13 \text{ r}$ and $228 \text{ r} \pm 4 \text{ r}$. These midline tissue doses are significantly different at $p < 0.01$. No single tissue-dose parameter was capable of removing the energy dependence effect; the midline tissue dose approached this more closely. The problems of local tissue inhomogeneities are discussed and specifically the role of bone shielding at lower energies is outlined.

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SUMMARY IN INTERLINGUA

Comparative Responsas Biologic De Canes A Radios Roentgen De 250 E 100 kvp

Canes bastarde esseva exponite a graduate doses de radios roentgen de 100 e 250 kvp, e le magnitudine del DL_{50} esseva calculate pro cata un del duo tractamentos. Basate super le dose aeree del linea central, iste magnitudes esseva $664 \text{ r} \pm 20 \text{ r}$ pro 100 kvp e $281 \text{ r} \pm 5 \text{ r}$ pro 250 kvp. Le doses histal de linea central esseva $312 \text{ r} \pm 13 \text{ r}$ e $228 \text{ r} \pm 4 \text{ r}$. Iste ultime doses es

significativemente differente a $p < 0.01$. Nulle parametro individual de dose histal esseva capace a eliminar le effecto del dependentia del energia. Le dose histal de linea central esseva plus proxime a iste condition.

Nulle differentias significative in le tempore medie del superviventia esseva constatate inter le duo tractamentos. Le

pathologia macroscopic esseva etiam essentialmente le mesme. Nulle significative differentias in le responsas al radiation del duo qualitates esseva observate super le base de doses que produceva le mesme mortalitate. Similmente, il non esseva possibile establir un relation de dose a

responsa quanto al punctos terminal studiate (numeration leucocytic, tempore de coagulation, numeration plachettal, etc.).

Es discute le problemas de local homogeneitates de histo. Es delineate specificamente le rolo del protection ossee a basse energias.



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A Serial and Chronographic Method of Aortography and Bilateral Arteriography of the Lower Extremities¹

ROBERT F. ELLZEY, M.D.

DUE TO RECENT advances in vascular surgery, the importance of accurate visualization of vascular lesions and of evaluation of circulation has become well established (1). Competent arteriography must conform to the three criteria formulated by Bazy and Reboul (2):

1. It must be complete, that is to say, it must show the whole arterial ramifications from the point of exploration to the end of the limb.

2. It must be serial, that is to say, it must show the characteristic moments of the filling of the arterial network into which the injection was made, in a series of pictures taken at intervals of seconds.

3. It must be chronographic, with measurement of the time which intervenes between the beginning of the injection of the opaque medium and the various roentgenographic exposures taken.

Several groups have attacked this problem successfully in regard to the first two requirements. In general, their methods have consisted of variations on the following scheme: one 14 × 17-inch cassette is placed under the abdomen and the pelvis while two 14 × 17-inch cassettes are placed under the legs, one half of each blocked off by lead. Following injection and after each exposure, the leg cassettes are shifted so that the unexposed part is in position for exposure and the previously exposed portion is protected by the lead shield. This procedure requires either having two roentgen tubes, one centered over the bifurcation of the aorta and the other over the knees, or moving the overhead tube following the first exposure from the abdomen to the knees. As a whole, the resulting radiographs are quite satisfactory (3, 4, 5). Another method consists of exposing a film, changing cassettes by hand while an assistant bodily pulls the patient cephalad a measured distance, and then exposing a second film, etc. (2). Morton and Byrne recently described a method employing a scanographic exposure of two 14 × 17-

inch films in a 14 × 36-inch cassette (6).

These methods have several complicating disadvantages, some of which the authors mention:

1. Several trained assistants are needed to "juggle" cassettes.

2. Two of these assistants must work close to the tube (150 cm. target-film distance) unprotected by a cone.

3. With rapid serial sequence of events involving several persons, a mistake due to the human factor is possible.

4. Damage to the tube could conceivably occur in the process of moving the stand with the hot rotating anode (4).

5. The injection of large amounts of concentrated opaque medium (up to 60 c.c.) is necessary.

6. The patient must be moved in relation to the radiographic table with the aortographic needle in place (2).

A recent article by Eyler of the Henry Ford Hospital describes a method of lumbar and peripheral arteriography utilizing several 14 × 36-inch cassettes in a manually operated cassette changer. The timing of exposures is accomplished by a simultaneous lead I electrocardiogram. The quality of the resulting roentgenograms is excellent (7).

The purpose of this paper is to describe a complete serial and chronographic method of aortography and bilateral arteriography of the lower extremities with the use of a rapid cassette changer and a special moving radiographic table.

The table was constructed from a discarded radiographic table top, the legs being attached in such a way that the longitudinal area beneath the table is clear of obstructing braces. The four rubber-tired wheels are noncasters, allowing the table to roll only in a straight line.

The patient is placed in a prone position

¹ From the Department of Radiology, General Rose Memorial Hospital, Denver, Colo. Accepted for publication in October 1957.

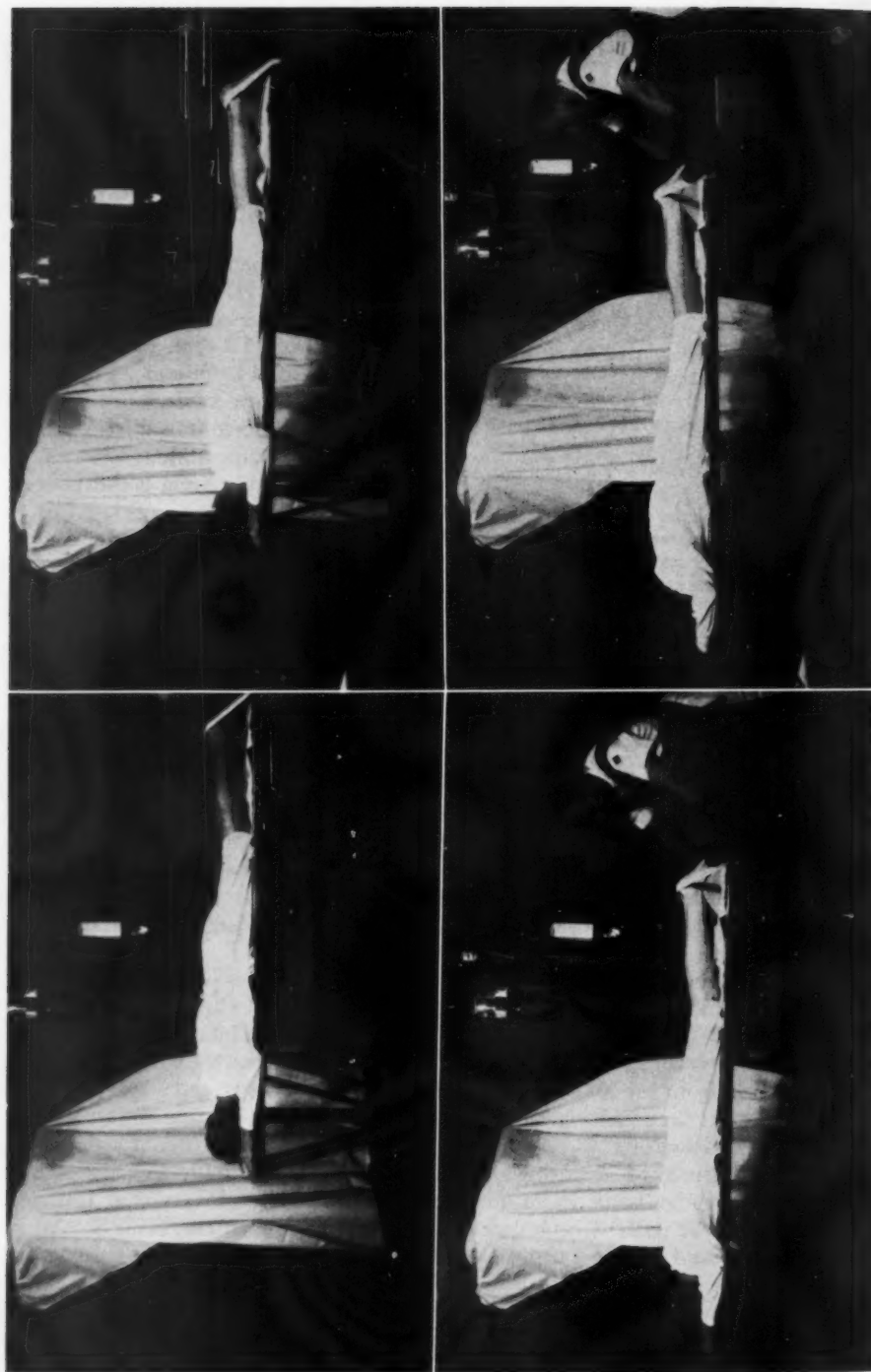


Fig. 1. Relationship of tube, patient, and serigraph during the serial exposures.



2A



2B

Fig. 2B. Delayed films confirm the presence of a partial block at the origin of the popliteal artery. Note stasis in the right femoral artery, with puddling of the opaque medium.

← Fig. 2A. Abdominal aortogram and peripheral arteriogram demonstrating extensive atheromatous changes bilaterally with delay in filling of the femoral artery on the right as compared with the left. There is a suggestion of a partial block at the origin of the popliteal artery on the right.

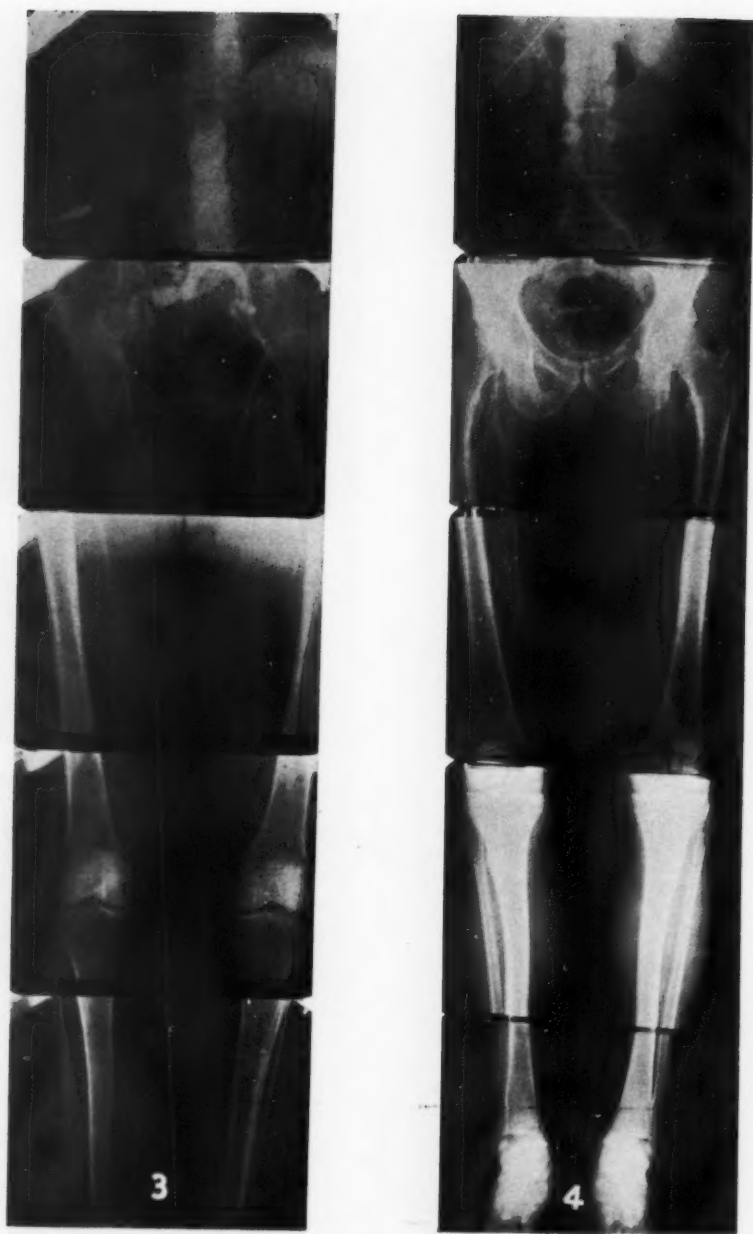


Fig. 3. Abdominal aortogram and peripheral arteriogram demonstrate aneurysmal dilatation of the aorta with multiple aneurysms involving the left common iliac artery and the right femoral artery near its origin. The superficial femoral artery is completely blocked at the origin of the profunda branch on the right. There are several tortuous collateral branches from the perforating ramifications of the profunda branch on the right. The femoral artery on the left is incompletely filled.

Fig. 4. Abdominal aortogram and peripheral arteriogram show excellent circulation bilaterally in the post-operative examination following replacement of the right common iliac artery with a nylon prosthesis. In the original roentgenograms, opaque medium is seen in the plantar arteries.

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on the table and is secured by strips of wide adhesive tape. A Sanchez-Perez seriograph is centered beneath the table at the abdominal aorta and the tube is centered to the changer.

Either a general or local anesthetic may be utilized. An abdominal aortic puncture is performed in the usual manner (8) above the renal arteries at the level of D-11. Langsam *et al.* puncture the aorta below the renal arteries because of danger of injection into the latter and the loss of opaque medium into the visceral vessels (3). At the level of D-11 there is little danger of puncturing the renals, and the loss of opaque medium in the mesenteric vessels has not precluded good films. Puncture has also been performed well below the mesenteric vessels with equally good results (see Fig. 3).

Following the injection of the medium (when 5 c.c. remain), the first exposure is made (Sanchez-Perez seriograph set for intermittent exposure and controlled by radiologist). The table is rolled cephalad 10 inches (marks at 10-inch intervals are made on the floor, in relation to the axle of the rear wheel of the table), and a second exposure is made. The procedure is continued until the ankles have been exposed and can then be reversed, with serial exposures from the ankles to the pelvis again. The exposure time is altered between serial exposures to compensate for variations in extremity thickness.

The rate at which the table is moved must be varied because of the rapid filling of the iliac and femoral arteries and the more delayed filling of the popliteal and tibial arteries. A future plan is to give an injection of radioiodinated serum albumin (RISA) in the aortographic needle and time the circulation to the feet with a Geiger counter, making possible a more accurate examination for each individual patient. A timer is attached to the seriograph so that the exact time of exposure is recorded on each film.

The exposure factors for the accompanying illustrations were 60 to 70 kv and 300 ma, with the time determined by the pa-

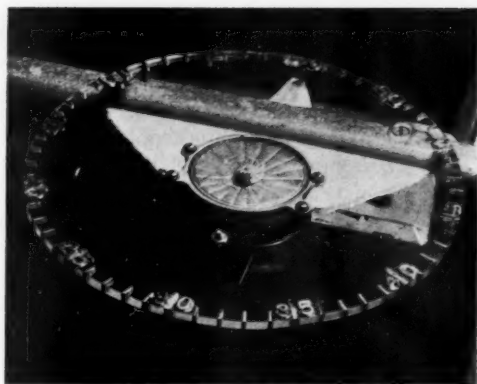


Fig. 5. The timing mechanism, consisting of a synchronous 1 r.p.m. electric motor with a plexiglass dial containing lead markers and numerals.

tient's size and the thickness of the part; *i.e.*, 1/15-1/10 sec. for the abdomen and pelvis, 1/30 sec. for the thighs, and 1/60 sec. for the legs and ankles. Target-film distance was 40 inches.

This examination provides:

1. Serial films of the aorta and vessels of both extremities.
2. The time of exposure on each film from the moment of injection.
3. A complete record of the entire abdominal aorta and extremity arteries to the feet.

The advantages of the method are as follows:

1. The risk to the patient is lessened by virtue of the single procedure and anesthesia.
2. Only one injection of a relatively small amount of contrast medium (25-30 c.c.) is necessary.
3. The patient does not move in relation to the table.
4. Only one person besides the injector need be in the room.
5. The need for a team of specially trained persons to "juggle" cassettes is eliminated.
6. A hot rotating anode tube does not have to be moved between exposures.
7. Coning down of the x-ray beam, reducing exposure of the patient and personnel, is possible.

A projected refinement of equipment and

technic is the attachment of a mechanical injector (9, 10, 11) to the moving radiographic table. This would completely eliminate any danger of disturbing the placement of the aortographic needle while the table is being moved, as well as insure rapid injection of the opaque medium.

The special rolling radiographic table makes a versatile accessory to the Sanchez-Perez seriograph. The table has been used for angiocardiology, for cerebral arteriography, and unilateral peripheral arteriography. It allows easy access to the cassette drawer without moving the patient even when he is positioned for a procedure. The distortion incident to having the part to be examined a short distance (1 inch) from the film has not been disturbing; it more than offsets the motion frequently transmitted to the patient by the violent changing of the heavy cassettes.

SUMMARY

A complete serial and chronographic method of aortography and bilateral arteriography of the lower extremities utilizing a Sanchez-Perez seriograph and a special rolling radiographic table is described.

ACKNOWLEDGMENTS: My appreciation is expressed to Drs. Morris H. Levine and Joseph H. Weiss for their advice and encouragement, to Mr. Lee J. Dudley, R. T., to the technical staff of General

Rose Memorial Hospital, Department of Radiology, and to Mr. William Jukola, who constructed the radiographic table.

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SUMMARIO IN INTERLINGUA

Un Methodo Chronographic A Serie Complete De Aortographia E De Arteriographia Bilateral Del Extremitates Inferior

Le autor obtene un complete studio serial del aorta abdominal e del vasos del extremitates inferior per medio del uso de un specialmente construite mobile tabula radiographic e un seriographo de Sanchez-Perez. Le risco pro le patiente es reduce

al minimo gratias al uso de un sol procedimento e un sol anesthesia. Un sol injection de un relativamente basse quantitate de substantia de contrasto es requirite (25 a 30 cm.³). Un sol assistente debe esser presente a parte le injector.

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Cerebral Angiography with Miokon¹

WILLIAM A. SHAFER, M.D., and CARL B. LECHNER, M.D.

CEREBRAL ANGIOGRAPHY has come to be one of the most valuable diagnostic procedures in the neurosurgical armamentarium. By injecting a contrast medium into the large vessels supplying circulation to the brain, one can detect and diagnose conditions which were previously impossible to demonstrate. In the development of cerebral angiography, however, many problems have arisen from the irritative effect of the contrast material on the arterial tree and perhaps even on the cerebral substance itself, producing a rather disturbing group of reactions ranging from a mild flushing and tingling sensation to shock and, in some instances, death. In spite of these hazards, as information accumulated it was realized that the procedure was vital, first to the progress of neurosurgery and, more recently, of vascular surgery.

The media originally used for angiography were, as in most beginnings, somewhat crude. It was even necessary, some believed, that anesthesia be utilized to allay the patient's suffering during the examination. This, it was thought, had a tendency to soften the blow and cushion the tendency to reaction. Continued search for less toxic drugs has been going on since the introduction of the procedure, so that it may be accomplished with less disturbance to the patient and without the use of additional noxious agents for their anesthetic effect.

We believe that in the product Miokon Sodium 30 per cent this problem has come much nearer to solution. Miokon Sodium has been used for intravenous urography in as high a concentration as 50 per cent. For cerebral angiography, however, it is recognized that the lowest concentration which will afford diagnostic films should be employed. Clinical trials with Miokon

Sodium 30 per cent, which had been found in pharmacological tests to have an extremely low toxicity, have convinced us that it is by far the best of the drugs utilized thus far for this purpose.

Miokon Sodium is a brand of sodium di-protrizoate, the sodium salt of 3,5-bis-propionamido-2,4,6-triiodobenzoic acid, an organic salt containing 57.3 per cent of iodine. It has proved to be among the least toxic of the materials in general use as contrast media for urography. In preliminary tests with massive doses, it was found that injection of fifteen to twenty times the maximum amounts recommended for man was tolerated by rats, mice, and dogs without evidence of serious toxicity. With the trypan blue staining technic no blood-brain barrier damage could be demonstrated in normal dogs, and no changes were seen in the electroencephalogram following the carotid injection of a total of 25 ml. of the medium in four seconds.

As in the case of the injection of any iodine substance, the usual precautions must be kept in mind. These are well known. Contraindications include acute vascular accidents, advanced arteriosclerosis, and extreme hypertension or cardiac decompensation, since the sudden rise in vascular pressure brought about by the necessarily rapid injection of the medium may increase the existing difficulty. A sensitivity test should be performed routinely as a precautionary measure, as in all injections of iodine compounds. A simple intravenous test for this purpose consists in the injection of 1 or 2 ml. of the medium intravenously, followed by close observation of the patient for ten minutes. Reaction may be evidenced by edema of the buccal mucosa, periorbital swelling, hives, respiratory difficulties, nausea and vomiting, fall in blood pressure, and signs of shock. Such phe-

¹ From the Departments of Neurosurgery and Radiology, Hamot Hospital and St. Vincent's Hospital, Erie, Penna. Accepted for publication in September 1957.

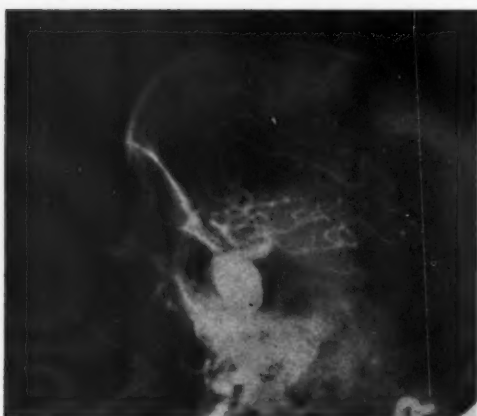


Fig. 1. Large aneurysm of internal carotid.

nomena are particularly noticeable in patients having a definite history of allergy. Even mild signs of reaction to the test dose contraindicate the examination. The procedure should not be employed within twenty-four hours of use of the same type of medium for fear of creating a sensitivity reaction.

In a series of 50 cases, representing a gamut of neurosurgical procedures in which Miokon Sodium has been used, we have encountered no untoward reactions or serious complications. On questioning the patient following the procedure the general consensus has been that a mild warmth develops on the side of injection. This, however, has not been accompanied by the flushing so commonly noticed with other media, nor has there been dilatation of the pupils nor the subsequent neurological changes which were prone to occur previously. Many patients formerly complained of a bitter or unpleasant taste, particularly when the common carotid system was injected, and the medium was seen to be coursing through the external carotid as well as the internal. Such complaints have been negligible with Miokon. In several instances in the present series a patient first received one of the earlier contrast media and was subsequently examined with Miokon Sodium. In every instance there was noticeably less disturbance with Miokon and it was frequently

commented that we must be improving our technic as the examination was so much less bothersome. This definitely adds to patient acceptance, which is necessary if the procedure is to be more widely utilized in the future.



Fig. 2. Subdural hematoma, showing compression of arterial tree.

The following technic we have found to be quite satisfactory in this series of 50 cases. A percutaneous puncture is carried out on the side that is to be visualized, at or slightly below the cricoid cartilage and approximately 3.0 to 3.5 cm. lateral to the midline. Eighteen-gauge Huber point needles are utilized, with the opening up. The curved end of the needle nicely slides along the inferior surface of the lumen of the vessel when puncture is made, allowing full penetration and a secure placement in the lumen. With but few exceptions, the procedure is carried out under local anesthesia, with little except analgesic premedication. Once the lumen of

the carotid artery is entered, a small amount of saline solution is injected to make certain that the needle is open, after observing the back-flow of arterial blood. A manual cassette changer is placed in posi-



Fig. 3. Sacular aneurysm of internal carotid.



Fig. 4. Normal angiogram.

have seldom found that further injections are needed, and often at this stage the needle is removed. If it is thought necessary to allow the needle to remain in place until the films are developed and visualized, a small amount of saline solution may be passed through the needle from time to time to keep the lumen open. Upon withdrawal of the needle, pressure is applied over the area for five minutes. To the date of this writing there has been no residual swelling of the neck and only minor complaints of residual soreness have been heard.

The quality of the films has been excellent. In one case in which another medium had been previously used, it was noticed that the vessels appeared larger during the same phase of injection with Miokon Sodium. This we have taken to be a further demonstration of less irritation by this medium.

The accompanying illustrations demonstrate what we consider uniformly good visualization.

In addition to allowing better visualization of the vessels because of their larger size, there is also the advantage that more of the smaller vessels can be seen. We infer that tumor filling is bound to be better with Miokon, but our series is not large enough to demonstrate this statistically. As we have changed from other opaque media to Miokon, we have been able to lengthen the exposure times so that visualization is enhanced. The reason for this is

tion and 10 c.c. of 30 per cent Miokon is injected, not so fast that maximum pressures are exerted, not so slow that dilution by the blood stream is too great. Approximately three or four seconds are necessary for the total injection of 10 c.c. This permits the radiologist to secure films including the arterial, capillary, and venous phases of the system and allows for maximum contrast. So slight is the degree of irritation which we find to be present, that even nervous and excitable individuals rarely move, making it possible to secure films which are clear and precise. Another injection of 10 c.c. is then quickly made, while another plane of reference is photographed, allowing for a complete series of anteroposterior and lateral views. We

obvious: since there is no irritation of the vessels, the patient does not move. The absence of vasospasm, the fact that the long exposure "catches" the opaque substance in more vessels, and the high iodine content of Miokon all make our recent angiograms technically more satisfactory than a former series. All this refers to the arterial phase of the examination.

We have not noted any striking change in the venous phase and the capillary filling does not seem to be different in the two groups of films. It seems to us that if we had had the advantage of more rapid serial-ography, the superiority of Miokon over the other opaque media might be even more apparent.

Safety of the Procedure: As we have had no untoward reactions or neurological sequelae in the series of patients in whom this procedure has been utilized, we con-

sider Miokon both safe and diagnostically valuable. Indeed, in view of the reactions sometimes incident to air encephalography and ventriculography, we consider cerebral angiography to be a less disturbing diagnostic procedure.

SUMMARY AND CONCLUSIONS

In an experience with 50 cases in which Miokon Sodium 30 per cent has been utilized, it has proved to be an excellent contrast medium, producing radiographs of high diagnostic quality with a minimum of side-reactions and patient disturbance. Cerebral angiography with this medium is a safe and extremely valuable diagnostic procedure and one that should command a wider use.

Note: Bibliography furnished on request.

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SUMMARY IN INTERLINGUA

Angiographia Cerebral Con Miokon

Miokon a natrium, que ha essite usate como substantia de contrasto in urographia intravenose, se ha provate como un eccellente medio pro angiographia cerebral quando illo es usate in plus basse concentrationes, i.e., de 30 pro cento. Illo es de basse toxicitate, produce pauc effectos irritative in le vasos, e face angiogrammas de qualitate superior. Le precautiones

usual e le contraindicationes que vale pro compositos de iodo in general debe evidentemente esser observate. In un serie de 50 casos, le reactiones lateral e le disturbance del patientes esseva minimal.

Con le uso de iste substantia de contrasto, angiographia cerebral es un salve e utilisime manovra diagnostic que merita esser usate plus extensemente.

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Simultaneous Occurrence of Subcostosternal (Morgagni) Hernia and Hiatus Hernia

Report of a Case¹

RONALD R. LUND, Lt., MC, USN, EUGENE C. CRISLER, Lt., MC, USN,
BILLY P. SAMMONS, Lt., MC, USN, and CHARLES GARTENLAUB, CAPT., MC, USN

THE SIMULTANEOUS occurrence of two separate nontraumatic diaphragmatic hernias is extremely rare. In 1941 Harrington (1) reported the first case of herniation of omentum through the foramen of Morgagni occurring simultaneously with hiatus hernia. In a review of the literature in 1951, Saltzstein, Linkner, and Scheinberg (2) were able to find 10 cases of bilateral subcostosternal (foramen of Morgagni) hernia.

As a single defect, diaphragmatic hernia is not unusual, particularly in persons over fifty years of age. The most common form is hiatus hernia, which comprises 70 per cent of all diaphragmatic hernias (3). Brick and Amory (4) found hiatus hernia in 1.3 per cent of 300 asymptomatic persons over the age of fifty, with an even higher incidence in symptomatic patients. Portis and King (5) reported an incidence of 7.5 per cent in a series of 133 patients over sixty.

Hernia through the foramen of Morgagni, on the other hand, is the rarest of diaphragmatic hernias, comprising only 2.6 per cent of such defects (2). In 430 cases of operated diaphragmatic hernia, Harrington (6) found only 8 to be subcostosternal.

Herniations through the esophageal hiatus and the foramen of Morgagni have several features in common. Both types are rare at birth, occurring usually in later life, most often after the age of fifty. Both are seen more commonly among women (2, 7). They are the only types of diaphragmatic hernia with true hernial sacs, suggesting that they develop after complete closure of the diaphragm. In

an excellent discussion of the subject Harrington (8) suggests that imperfect embryological development plays an important role in the etiology of these hernias, in spite of the delay in their appearance.

Bizarre symptoms are often encountered in both hiatus hernia and subcostosternal hernia. Frequently these hernias are confused radiographically with pleural cyst, pulmonary cyst, pericardial cyst, hydatid cyst, empyema, mediastinal tumor, intrathoracic tumor, or other intrathoracic conditions, including various forms of cardiac disease (3, 9). If the hernia contains hollow viscera of the gastrointestinal tract, the diagnosis is usually readily made by barium contrast studies. When these fail to reveal the nature of the abnormality, pneumoperitoneum may be used (10). Such a procedure may outline the hernial sac and demonstrate its extra-pleural character.

The following case is presented as the second reported example of simultaneous occurrence of hiatus hernia and subcostosternal hernia. It is, as far as we can determine, the only reported case in which both defects contained hollow viscera, permitting the diagnosis to be made by barium contrast studies.

CASE REPORT

A 62-year-old white female sought medical attention in August 1957 because of a five-year history of intermittent, postprandial, substernal pain, radiating on occasion to the left shoulder and frequently accompanied by moderate dyspnea. The pain was not related to any type of food and was partially relieved by antacids. Nausea and vomiting were occasionally experienced. Orthopnea was present

¹ From the Department of Radiology, U. S. Naval Hospital, St. Albans, N. Y. (C. G., Chief, Department of Radiology; R. R. L., E. C. C., B. P. S., Residents in Radiology). The opinions expressed are those of the authors, and do not necessarily reflect the views of the Medical Department or the Department of the Navy.

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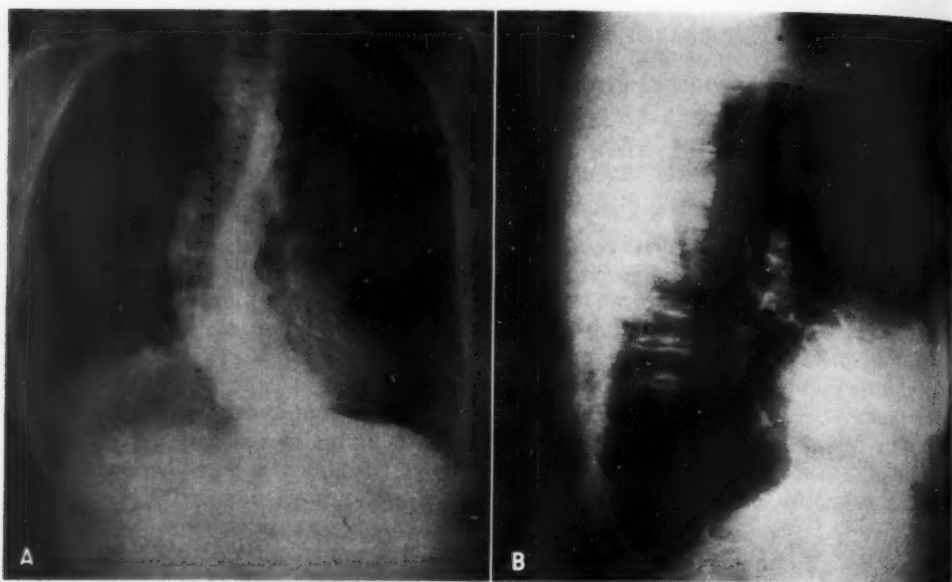


Fig. 1. A. Postero-anterior roentgenogram of the chest demonstrating the density obscuring the right cardiophrenic angle. The configuration of the gas pattern within this mass suggests intestinal contents. A moderately severe scoliosis of the thoracic spine is noted.

B. Lateral view of the chest, localizing the density to the anterior half.



Fig. 2. Simultaneous barium enema and barium meal study, showing the transverse colon within a large foramen of Morgagni hernia and the fundus of the stomach to have herniated through the esophageal hiatus.

intermittently, and a chronic cough productive of moderate amounts of yellowish sputum was reported.

Three years previously the patient had sought medical aid for these symptoms and was reportedly told that routine chest films showed a "lung cyst" and that surgery was not indicated. Her symptoms persisted, and about eighteen months later she began to experience alternating diarrhea and constipation. In June 1957 she had a sudden onset of right shoulder pain followed by one episode of blood-streaked sputum and one episode of blood streaking in the stool. Tarry stools had been passed intermittently for a year, and there had been a 23-pound weight loss in the past nine months. Except for repeated breast abscesses and two cesarean sections, the past history was not noteworthy.

The physical examination was unremarkable except for diastasis recti and dorsolumbar scoliosis. The chest was clear to percussion and auscultation.

Routine white blood count, differential count, serology, and urinalysis were within normal limits. The hemoglobin was 14.5 gm. per cent and the hematocrit was 0.44. An electrocardiogram was normal.

Roentgen examination of the chest revealed an increased density anteriorly in the right lower lung field extending laterally from the cardiophrenic angle. An area of radiolucency within this density suggested gas-containing bowel (Fig. 1). A subsequent barium enema study showed this density

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to be a portion of transverse colon herniated into the chest through the foramen of Morgagni. An upper gastrointestinal series revealed an additional diaphragmatic defect in the form of a sliding type hiatus hernia, both hernias being demonstrable at the same time (Fig. 2).

At operation, Sept. 12, 1957, the roentgen diagnosis of subcostosternal hernia and hiatus hernia occurring simultaneously was confirmed and they were surgically corrected.

DISCUSSION

This case illustrates the manner in which the chest signs and symptoms of diaphragmatic hernia may delay accurate diagnosis. For three years the patient was believed to have primary pulmonary disease. Symptoms of melena and alternating diarrhea and constipation finally directed attention to the gastrointestinal tract, and the diagnosis was then made.

The melena probably resulted from the hiatus hernia, since bleeding is relatively frequent in this condition but is unusual in subcostosternal hernia. In spite of the evidence of chronic blood loss, the patient showed no anemia. This can be explained by the tendency toward polycythemia often exhibited in cases of large subcostosternal hernia (3). This polycythemic tendency is probably secondary to decreased pulmonary function resulting from the hernial contents in the chest.

As is usual in cases of diaphragmatic hernia, there is no history of trauma in this case. However, the fact that this patient had diastasis recti, in addition to two diaphragmatic hernias, suggests a general weakness in the supporting structures of her peritoneal cavity. Less stress is necessary to produce a hernia in such an individual.

SUMMARIO IN INTERLINGUA

Occurrentia Simultanea De Hernia Subcostosternal (Morgagni) E De Hernia De Hiato. Reporto De Un Caso

Es reportate un caso de hernia subcostosternal (Morgagni) occurrente simultaneamente con hernia de hiato. Isto pare esser le prime caso in le litteratura in que ambe defectos contineva visceres cave de maniera que un positive diagnose roentgenologic

SUMMARY

1. A case of subcostosternal (Morgagni) hernia and hiatus hernia occurring simultaneously is reported and discussed. This is believed to be the first such case in the literature in which both defects contained hollow viscera, making possible a positive preoperative roentgen diagnosis.

2. A comparison of some of the clinical features of these types of hernial defect is presented, and the diagnostic possibilities are mentioned.

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preoperative esseva possibile. Durante un periodo de tres annos le patiente esseva considerate como suffrente de primari morbo pulmonar. Symptomas de melena e le alternation de diarrhea e constipation tirava le attention al vias gastrointestinal.

Multiple Benign Gastric Ulceration

Report of Two Unusual Cases¹

EDSEL S. REED, M.D., JOHN H. WILLARD, M.D., and PAUL O. WELLS, M.D.

THE RECENT EXPERIENCE of encountering 2 patients with multiple, simultaneous gastric ulcers has prompted this report. One patient demonstrated both surgically and roentgenographically the rare occurrence of two benign ulcers of the greater curvature of the stomach and a duodenal ulcer. In the second case there was x-ray evidence of four gastric ulcers present at the same time. More than three gastric ulcers in a patient is a rarity.

CASE I: L. G., a 32-year-old housewife, was admitted to the Harlan Memorial Hospital Dec. 11, 1956, complaining of increasingly severe epigastric pain of three months duration, unrelated to the ingestion of food. She stated that she had experienced intermittent vomiting of retained and undigested food over a period of several years. Physical examination was negative except for tenderness to palpation over the epigastric area. The past history revealed several prior hospital admissions with diagnoses of chronic bronchitis, lumbosacral disk syndrome, spinal scoliosis, and parametritis. There had been vague abdominal complaints for several years and at one time the patient had lost 40 pounds in weight over a six-month period. At the time of her admission for lumbosacral disk syndrome, in July 1956, she complained of occasional vomiting and distention. An x-ray examination of the upper gastrointestinal tract in August 1956 was reported to be within normal limits.

An upper gastrointestinal examination was performed Dec. 11, 1956, and a diagnosis of duodenal ulcer was made. Treatment consisted of a bland diet, antacids, anticholinergics, and mild sedation. The patient was discharged and followed in the outpatient department. She did not respond satisfactorily, however, and continued to complain of intermittent vomiting and epigastric pain, which again became severe, requiring rehospitalization Jan. 6, 1957. A gastrointestinal examination (Figs. 1 and 2) showed a duodenal ulcer on the posterior wall of the bulb adjacent to the pylorus and two gastric ulcers on the greater curvature, all benign in appearance. Gastroscopy was performed on Feb. 1, 1957, and, although no ulcer craters were seen, one depression on the greater curvature was reported as having a benign appearance.



Fig. 1. Case I. Film of the stomach with the patient prone. Arrows point to the two ulcers on the greater curvature.

In view of the combined duodenal and gastric lesions and their failure to respond to a medical regimen, and after examination of frozen sections of the lymph nodes and the ulcer margins was reported as showing no evidence of malignancy, a subtotal gastric resection was performed. The description of the surgical specimen (Fig. 3) was as follows: "The specimen consists of a stomach and a portion of the duodenum. . . . At the pyloric ring an ulcer measuring 1.5 cm. in diameter and 5 mm. in depth is found. The margins are reddish-yellow in color and the mucosa surrounding this is flattened and a yellowish-red color. On the greater curvature, near the pylorus, located 2.5 cm. from the pylorus, is an ulcer similar in size and shape and appearance to the first described. The third ulcer on the greater curvature is 5.5 cm. from the pyloric ring, is elliptical in shape, and measures 2.2 × 1.1 cm. and 4 mm. in depth. The base of these ulcers is yellowish-gray and the margins a deep fiery red and yellow color." Microscopic study of the ulcers showed "no evidence of malignancy. . . . There is infiltration of the epithelium and submucosa with inflammatory reaction consisting of foci of lymphocytes, plasma cells, and leukocytes."

¹ From the Departments of Radiology and Medicine, Harlan Memorial Hospital, Harlan, Ky. Accepted for publication in November 1957.



Fig. 2. Case I. Multiple spot films made during the examination. Arrows indicate the ulcer on the posterior wall of the duodenum and both gastric ulcers.

The patient made a satisfactory recovery and was discharged Feb. 17, 1957.

A final admission occurred April 21, 1957, because of edema of the legs and feet following an acute upper respiratory infection with headache, nausea, and vomiting of three weeks duration. No abnormality of the renal system was demonstrated and the gastrojejunostomy was of normal appearance radiologically. Studies indicated that the edema was on a nutritional basis. Response to therapy was good and the patient was discharged May 10, 1957.

Comment: The often repeated medical dictum that gastric ulcers on the greater curvature are malignant has been questioned in recent years in view of the increasing number of benign lesions reported. As recently as 1945, Lahey (11) stated that he had never seen an ulcer on the greater curvature which was benign. In 1952, however, in discussing a paper, he reported a series of 6 cases and said: "Although I think it probably sound to say

that all ulcers of the greater curvature should be resected because the incidence of benign ulcers is so low, it does not mean that we can be as sure as we once were that every one is malignant" (12). Friedman and Epstein (5) in 1950 found only 24 cases in which the diagnosis was conclusive and added 2 of their own. In 1956 Feist and Littleton (4) in a summary of the literature listed a total of 79 cases and reported 3 from their experience. Recent reports by Ochsner (13), Solosko *et al.* (15), and Elliott *et al.* (3) have contributed to the number of benign gastric ulcers of the greater curvature.

A summary by Kirsh (10) of the published reports of benign and malignant ulcers in this location reveals that from 20 to 100 per cent are malignant, with an average of about 50 per cent; this is in contrast to the earlier view that these ulcers are almost universally malignant.



Fig. 3. Case I. Surgical specimen of the stomach after fixation and removal of blocks for microscopic examination. The three ulcers are all well demonstrated and show a benign gross appearance. The gastric ulcers are to the right and are within 1 cm. of the mesenteric attachment. The duodenal ulcer is to the left.

In other reported series the incidence of benign ulcers occurring on the greater curvature varies considerably. Thus, Palmer (14), in a study of 100 benign gastric ulcers, found 9 per cent on the greater curvature, while Gott and others (6) found 1.9 per cent of 138 ulcers in that location. Ochsner reported the incidence as 5 per cent in 148 microscopically verified cases. He stated that the reported incidence ranged from 1 to 9 per cent.

Multiple benign gastric ulcers of the greater curvature demonstrated both roentgenographically and surgically are extremely rare. In a study at the Cleveland Clinic, Brown and Intriore (2) found 2 cases of multiple benign ulcerations in this location. One patient had two ulcers and the other four. In neither case, however, did the roentgen examination demonstrate the multiplicity of the lesions. Two cases, each showing three simultaneous gastric ulcers, were reported by Johnson and Hawthorne (7). In one of their patients all 3 ulcers were on the greater curvature.

CASE II: S. B., a 16-year-old white male, was first seen at the Harlan Memorial Hospital Dec. 12,

1956, because of epigastric pain and associated nausea and vomiting of approximately three days duration. The pain was sharp in character and did not radiate from the epigastrium; it was occasionally relieved by the ingestion of food. There was no history of hematemesis or melena. The patient had not experienced any previous similar episodes.



Fig. 4. Case II. Film of the stomach with the patient prone showing three distinct gastric ulcers. The fourth ulcer is not well visualized.

He denied ingestion of drugs or alcohol in the period immediately prior to the onset of the present illness; he did, however, give a history of drinking approximately one pint of whiskey weekly for a period of two years in the relatively recent past. He had smoked approximately one package of cigarettes daily for six to seven years.

Physical examination revealed a tall, slender, well developed, white male in no acute distress. There was some tenderness, with muscle guarding, in the epigastric region. The patient's lower teeth were carious and there was evidence of pyorrhea and gum retraction. He wore an upper dental plate. Several cervical nodes were palpated on the left.

An x-ray examination of the upper gastrointestinal tract on Dec. 14, 1956, revealed marked retention of secretions, moderate dilatation of the stomach, and a distorted outline of thickened mucosa, leading to marked deformity of the distal third of the stomach. Four separate ulcers, one measuring 2 cm. in diameter, were identified in the antral region of the stomach (Figs. 4 and 5). The duodenal bulb was normal.

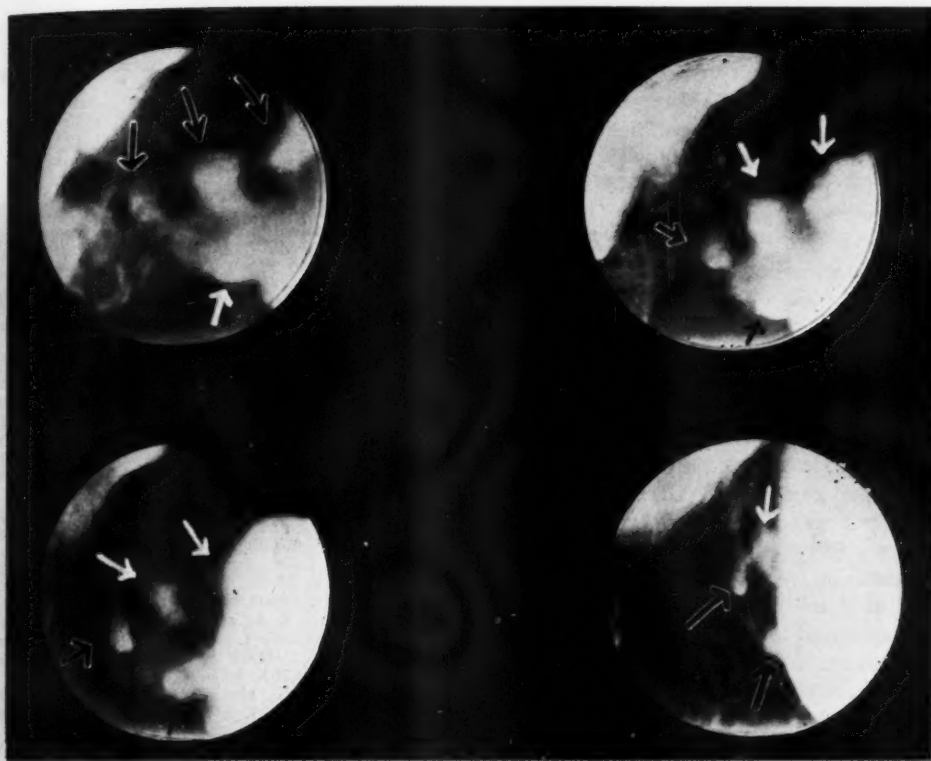


Fig. 5. Case II. Spot films in several projections showing the four multiple gastric ulcers primarily on the posterior wall of the antrum of the stomach.

The patient was given antispasmodics, antacids, and mild sedation. Dietary therapy included hourly feedings of milk and cream, with progression to a six feeding bland diet. There was marked and rapid symptomatic relief. Gastroscopy on Dec. 19, 1956, revealed, at the level of the angulus on the anterior wall, a small deep ulcer with a gray necrotic base. Surrounding hyperemia was absent. There was a slight polypoid reaction at the distal margin of this ulcer. A second ulcer was noted on the posterior wall just distal to the ulcer mentioned above. There was no apparent diffuse infiltration of the stomach wall. Restudy of the upper gastrointestinal tract was performed Dec. 21, 1956, following intensive medical management, and only one of the previously reported ulcers could be demonstrated.

Laboratory studies revealed no significant abnormality. Total gastric acidity following an alcohol test meal reached a peak of 59 degrees within one hour and this was maintained for the remainder of the test. Free gastric acidity reached a peak of 54 degrees at the end of two hours. Stools were positive for occult blood on admission, but this finding had disappeared before discharge on Dec. 24, 1956.

A repeat gastrointestinal series on Jan. 14, 1957, showed no evidence of the ulcers, but there were still coarsening of the gastric folds and some hypersecretion in the stomach. The patient was asymptomatic and had gained weight following discharge.

DISCUSSION

Pathologists not uncommonly report the presence of small acute superficial erosions and ulcerations of the stomach in resected specimens and at autopsy. The question as to why the disease is manifested usually by a single ulcer and less frequently by multiple ulcers remains unanswered. As many as thirty-two acute superficial gastric ulcers have been found at autopsy (17). Discrete multiple chronic gastric ulcers are infrequent (7). They may occur in the stomach alone or in association with duodenal ulcers or gastric carcinoma, although Welch and Allen (18) at the Massachusetts General Hospital, in a re-

view of 512 cases of gastric ulcer, reported that 8 per cent were multiple and concluded that the multiplicity of ulceration usually indicated benignity. Benign gastric ulcer was diagnosed radiographically in 879 cases from the Lahey Clinic (16). Twenty-one of the patients, or 2.4 per cent, showed multiple ulcerations. Bockus (1) reported a case in which there was x-ray evidence of three gastric ulcers on the lesser gastric curvature, all of which healed without surgery.

A study of 1,475 cases of gastric ulcer by Judd and Proctor (8) in 1925 demonstrated two or more ulcers in 87 cases (6 per cent). In 63 per cent of these 87 cases there were two ulcers, in 20 per cent three ulcers, and in 17 per cent more than three ulcers. In only 2 cases, however, was there x-ray evidence of two or more ulcers. Katz and Bierenbaum (9) in April 1957 reported a case of four simultaneous gastric ulcers demonstrated on roentgenograms and at subsequent surgery. They report that, to the best of their knowledge, this is the first such case reported.

SUMMARY

Two unusual cases of multiple gastric ulcers are presented. One patient had two benign gastric ulcers of the greater curvature and a duodenal ulcer demonstrated both by x-ray examination and in the surgical specimen. The other patient had four simultaneous gastric ulcers shown roentgenographically. These healed completely after one month of intensive medical treatment.

A review of the literature indicates that ulcerations of the greater curvature represent from 1 to 9 per cent of all benign gastric ulcers, while malignant ulcers range from 20 per cent to 100 per cent of all ulcers in that location. In view of the likelihood of such ulcers being malignant, surgical resection would appear indicated. The occurrence of two or more gastric ulcers at the same time apparently does not add to the likelihood of malignancy. A period of therapeutic trial under close observation seems justifiable.

NOTE: We are indebted to Kenneth Conlan, M.D., and Garret Craft, M.D., for Case I, and to Eugene Wicker, M.D., for the pathological description.

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SUMMARIO IN INTERLINGUA

Multiple Ulceration Gastric Benigne. Reporto De Duo Casos Inusual

Es presentate duo casos inusual de multiple ulcères gastric. Un del patientes habeva duo benigne ulcères gastric del curvatura major e un ulcere duodenal que esseva demonstrate primo per le examine roentgenologic e postea in le specimen chirurgic. Le secunde patiente habeva quatro simultanee ulcères gastric que esseva demonstrate roentgenographicamente. Illos se resanava post tractamento medical.

Un revista del litteratura indica que ulcerationes del curvatura major repre-

senta inter 1 e 90 pro cento de omne benigne ulcères gastric, durante que ulcères maligne in ille loco figurava con inter 20 e 100 pro cento del casos in le series publicate. A causa del probabilitate del character maligne de tal ulcères, resection chirurgic pare esser indicate. Le occurrentia simultanee de duo o plure ulcères gastric non pare augmentar le probabilitate de malignitate. Un periodo de experimentation therapeutic sub observation meticulose pare esser justificate.



Congenital Enteric Duplication Cyst¹

Report of a Case Diagnosed Roentgenologically

BERNARD KLEPPEL, M.D.²

PREOPERATIVE ROENTGEN diagnosis of the uncommon congenital duplication cyst of the small bowel is rarely made. With growing awareness of the nature of this anomalous malformation, radiologists apparently are learning to demonstrate its presence with increasing frequency. Kump, Jorgens and Rigler (4) have reported and discussed the diagnostic and prognostic significance of roentgenologically demonstrable ectopic gastric mucosa in a congenital small bowel diverticulum. In the following case, the demonstration by spot-films and routine radiographs of ectopic gastric rugae lining a saccular, mobile out-pocketing of the intestinal wall led to the correct preoperative diagnosis.

CASE REPORT

G. M., a 3-year-old white male, was completely well until one day prior to his admission to Sarah Morris Hospital of Michael Reese Hospital Medical Center, May 2, 1957, because of increasing pallor, anorexia, nausea, vomiting, and profuse rectal bleeding. Gross bleeding from the rectum continued for twenty-four hours after admission and then ceased completely. Each bloody bowel movement was preceded by crampy, generalized abdominal pain. No history of abnormal bleeding tendency was elicited.

On admission, the pulse was 104; temperature 102° F; blood pressure, 90 mm. Hg systolic and 20 mm. Hg diastolic; hemoglobin 6.7 gm. per 100 ml.; hematocrit 19 per cent. The white blood cell count was 14,500, with a normal differential count. The abdomen was soft, flat, and nontender; bowel sounds were normal. There were no unusual palpable masses. The bleeding time was 3.5 minutes (Duke) and the clotting time was 8.5 minutes (Lee-White).

Barium enema examination failed to disclose the presence of a polyp or of an intussusception. An upper gastrointestinal examination showed no abnormality. On May 11, 1957, small intestinal examination revealed an unusual group of mucosal folds adjacent to the lower jejunum or proximal ileum. These folds resembled gastric rugae (Figs. 1-3). On fluoroscopic observation and spot-films



Fig. 1. Two-hour-motility study. Prominent mucosal folds resembling gastric rugae in lower quadrant. See also Figs. 2 and 3.

the spherical pouch containing the rugal folds was found to be mobile; it was attached to the bowel by a stalk and showed peristaltic activity (Fig. 3).

The diagnosis of Meckel's diverticulum or duplication cyst lined with ectopic gastric mucosa was made.

On May 17, 1957, exploratory laparotomy was performed. Approximately 40 cm. from the ileocecal valve, a saccular soft mass arose near the mesenteric border of the ileojejunum portion of the small bowel. The mass measured 6.0 cm. in diameter. The lumen of the pouch communicated with the small bowel by means of an orifice measuring 3.0 cm. in diameter. Several engorged blood vessels passed over the smooth but hyperemic serosal surface (Fig. 4).

¹ Accepted for publication in October 1957.

² Associate Director, Department of Diagnostic Roentgenology, Michael Reese Hospital, Chicago, Ill.

Operation: A segment of small bowel with attached duplication cyst was excised and direct anastomosis of the ends of the intestine effected. The postoperative course was uneventful and at the time of this report the child is well.

Pathologic Report: Grossly, the mucosal lining of the cyst wall disclosed gastric mucosa containing focal areas of hemorrhage, as well as a true muscular coat of two layers (Fig. 5). **Pathologic diagnosis** (Dr. Otto Saphir): Congenital duplication of gastrointestinal tract (enteric cyst lined predominantly by gastric mucosa).

DISCUSSION

Congenital bowel diverticula are of two general types:

1. Meckel's diverticulum, which occurs in 2 per cent of the population, is a remnant of the embryonic yolk sac or vitelline duct. It is found on the antimesenteric border of the ileum and communicates with the lumen of the bowel. The mucosal lining of the diverticulum may be entirely ileal or it may contain islands of ectopic gastric or pancreatic tissue.

2. Intestinal duplications are described as "spherical or elongated hollow structures which (1) possess a coat of smooth muscle, (2) are lined by a mucous membrane similar to some part of the alimentary canal, and (3) are intimately attached to some part of the alimentary tube" (1). These anomalies may be found at any point along the alimentary canal but are most common in the ileum, along its mesenteric border. In 55 of 68 cases studied by Gross, Holcomb and Farber (3) there was no communication with the lumen of the adjacent gut. Although these structures are variously named "enterogenous cysts," "giant diverticula," "ileum duplex," and "unusual Meckel's diverticula," it is the belief of these authors that all duplications have a similar origin, though the exact embryogenesis is unproved.

Most intestinal duplications give rise to symptoms during early life, such as abdominal pain and symptoms of intestinal hemorrhage, obstruction, perforation, and inflammation. In the presence of gastric mucosa, peptic ulceration with bleeding may occur either within the duplication cyst or in the contiguous bowel.

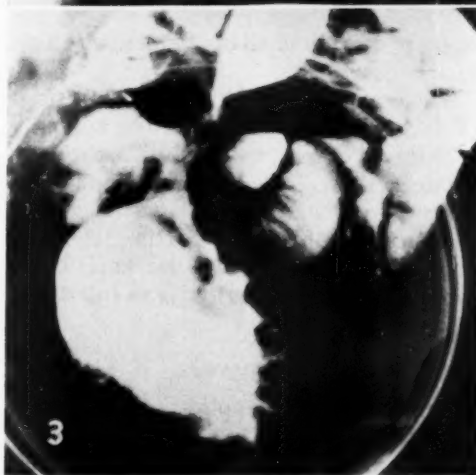


Fig. 2. Magnified view of part of Fig. 1.

Fig. 3. Compression spot-film showing communication with lumen of intestine and gastric rugae.

In the case reported here, the appearance of a sheet of gastric mucosa lying in close proximity to the distal small bowel was considered diagnostic of an intestinal duplication rather than of a Meckel's diverticulum. In the opinion of the pathologist (Dr. O. Saphir), the latter would be more



Fig. 4. Surgical specimen. Gastric rugae in duplication cyst arising from mesenteric border of small bowel.

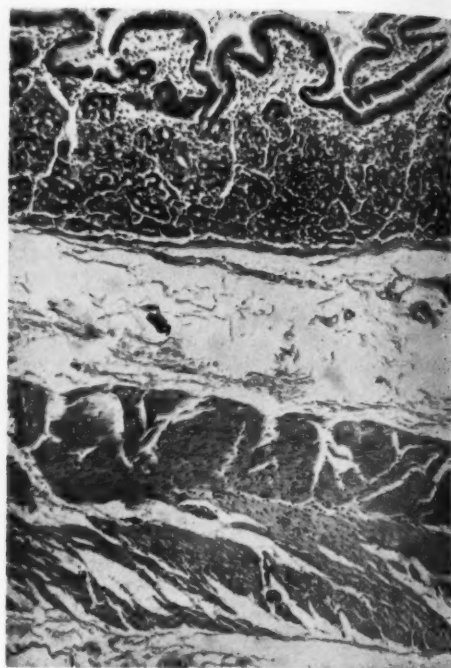


Fig. 5. Microscopic section ($\times 10$) showing gastric mucosa and two layers of muscularis.

likely to contain small islands of heterotopic gastric tissue (10).

The report by Kump, Jorgens and Rigler (4) has directed attention to the fallibility of roentgen criteria for exact differentiation of Meckel's diverticulum from duplication or enteric cysts. They have suggested, for purposes of x-ray reporting, the general designation of congenital small bowel diverticulum. The writer is in full agreement with this view.

SUMMARY

A case of enteric duplication cyst is presented. The patient was a three-year-old male with severe abdominal pain, vomiting, and massive rectal bleeding. The diagnosis was made preoperatively by roentgen demonstration of ectopic gastric mucosa and was confirmed at surgery.

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SUMMARIO IN INTERLINGUA

Congenite Cyste De Duplication Enteric

Es presentate un caso de cyste de duplication enteric. Le patiente esseva un puero de tres annos de etate con sever dolores abdominal, vomito, e massive

sanguination rectal. Le diagnose esseva facite ante le operation per le demonstration roentgenologic del presentia ectopic de mucosa gastric.



Intraluminal Mesentery as Cause of Small-Bowel Obstruction¹

HOWARD J. BARNHARD, M.D., and W. DEAN HIDY, M.D.

WHILE IT IS difficult to be absolutely certain that one has found a "new" entity, we have not been able to find in the literature any mention of mesentery within the lumen of the bowel. We feel, therefore, that this single case, with striking roentgenologic features, is worthy of reporting. We will, in addition, consider the possible mechanisms of the occurrence.

CASE REPORT

A 26-year-old colored male gave a two-year history of intermittent abdominal pain, unrelated to exercise, food intake, or trauma. The bouts of severe periumbilical pain, with radiation to the right lower quadrant, usually lasted from one to three days. During the attack the patient suffered from obstipation and would often vomit bile-stained material, but there was no hematemesis or feculent vomitus. Alkalis offered no relief. The symptoms subsided spontaneously with the passage of a copious stool, and the patient was left without ill effects.

On admission to University Hospital, the chief complaint was severe abdominal pain with nausea and vomiting. These symptoms had been present

for three days, during which time there had been no bowel movement and no flatus had been passed. Examination revealed an acutely ill patient, whose temperature was 99° F., pulse 100 per minute, and blood pressure 130/80. The slightly distended abdomen was generally tender to palpation, especially in the right lower quadrant. Muscle guarding was present on the right, with rebound tenderness at McBurney's point. No enlarged organs or masses were palpable. Rectal examination revealed tenderness on both the right and left sides; there were no feces in the ampulla. Findings on proctosigmoidoscopy were normal except for minimal hemorrhoid formation.

Laboratory Studies: The hemoglobin was 7.3 gm.; hematocrit 27 per cent; leukocyte count 9,300, with 69 polymorphonuclears, 29 lymphocytes, 1 eosinophil, 1 monocyte. The following were normal: urinalysis, sickle-cell preparation, serum amylase, serum calcium, nonprotein nitrogen.

Roentgenologic Examination: Three days prior to admission, chest films were normal. Upright and supine views of the abdomen demonstrated a relative absence of gas throughout the colon, with a few scattered loops of small bowel principally in the right upper quadrant. On the third hospital day a barium meal revealed mild duodenal and

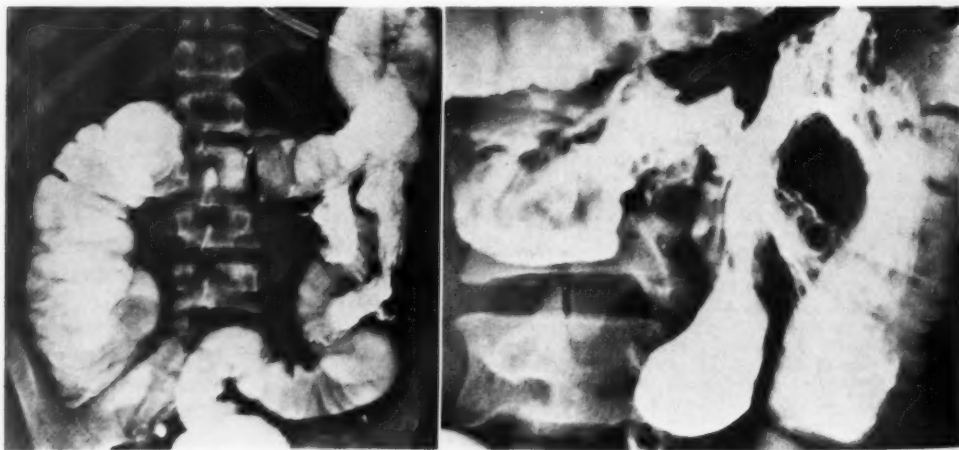


Fig. 1 (left). Barium-filled loops of small bowel as seen overlying the descending colon. The barium in the small bowel is residua from the barium meal given six days previously. The barium in the colon was introduced just before the radiograph was made. No abnormal connection existed between small and large bowel.

Fig. 2 (right). Roentgenogram obtained at the same time as Fig. 1 but in the left anterior oblique position. On both illustrations note that the barium forms multiple lines which parallel the long axis of the small bowel.

¹ From the University of Arkansas Medical Center, Little Rock, Ark. (H. J. B., Assistant Professor, Department of Radiology; W. D. H., Trainee, National Cancer Institute, Department of Surgery). Accepted for publication in October 1957.

jejunal dilatation. On the ninth day examination of the colon was about to be started when the fluoroscopist noticed that loops of small bowel on the left were still filled with the barium given six days previously. This opacification is demonstrated on Figure 1 against the background of the filled colon. Figure 2 shows the loops "opened up" on the left anterior oblique projection.

Course: Since the clinical picture was that of bowel obstruction, the patient was put on Wangenstein suction. Supportive therapy included blood, intravenous fluids, and antibiotics. The response was favorable, with decompression within four days, and the patient was free of pain and tolerated a liquid diet. In consideration of the history of recurrent intestinal obstruction and the roentgen findings, a laparotomy was performed two weeks after admission. Approximately 20 inches from the ileocecal junction, several loops of ileum were found to be twisted and matted together by an old inflammatory reaction (Fig. 3). This portion of abnormal ileum was resected and a primary end-to-end anastomosis was done. The patient had an uneventful postoperative course and has remained asymptomatic.

Pathology: Once freed of adhesions which had formed it into one large loop, the specimen measured 30 cm. in length. The lumen was patent throughout, but into it there protruded tissue which grossly and microscopically resembled slightly necrotic mesentery. Barium sulfate was adherent to its surface. The mesenteric remnant measured 15×8 cm. and entered the ileum through an ulcer on the mesenteric side of the bowel. The ulcer measured 8 mm. in diameter and showed marked hypertrophy of the surrounding mucosa.

DISCUSSION

Roentgen Findings: The initial films of the abdomen and the barium meal study present the picture of partial small bowel obstruction. The barium sulfate deposited on the intraluminal mesentery undoubtedly resulted in the small bowel density. As the opacified mesentery lay within the confines of the ileum, it was thrown into long folds running parallel with the bowel walls. This appearance is somewhat suggestive of barium in and around *Ascaris lumbricoides* infestation. Other possibilities include gangrenous bowel, fistulous tract, duplication of the bowel, and perforation with extraluminal barium walled off by mesentery or omentum. Another entity which should be considered in the differential diagnosis is a gauze sponge left behind at operation. The sponge may

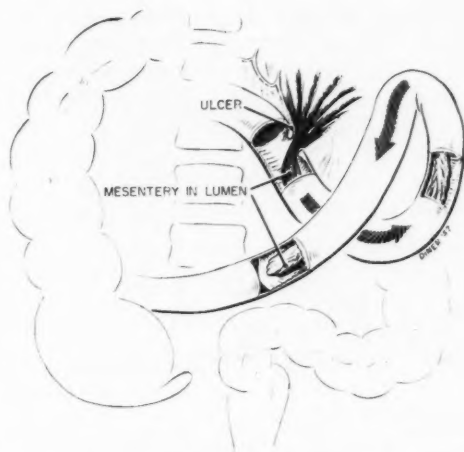


Fig. 3. Diagrammatic representation of condition found at operation.

enter the intestinal lumen through a fistulous tract and present barium meal findings similar to those of intraluminal mesentery (5).

Mechanism: Three mechanisms come to mind whereby mesentery might be trapped inside the bowel. One may first consider whether mesentery (or omentum) which overlies a bowel perforation might be pulled within the lumen by peristaltic action. In the presence of bowel contents released during perforation, it appears more likely that mesentery or omentum would become fixed by adhesions and therefore quite resistant to any attempt by peristalsis to pull it within the lumen. Furthermore, there would seem to be considerable chance of gangrene of the bowel supplied by the involved mesentery, due to strangulation of the mesenteric vessels; this would be particularly true of small bowel mesentery with its terminal, rather than looped, artery system.

A second method might be invagination of a Meckel's diverticulum. Invagination is widely reported, though usually as a cause of intussusception (4, 6). In those instances where the diverticulum has its own small mesentery (mesenteriolum) (1), this structure would be drawn in as the invagination occurred. With the blood supply thus compromised, the wall

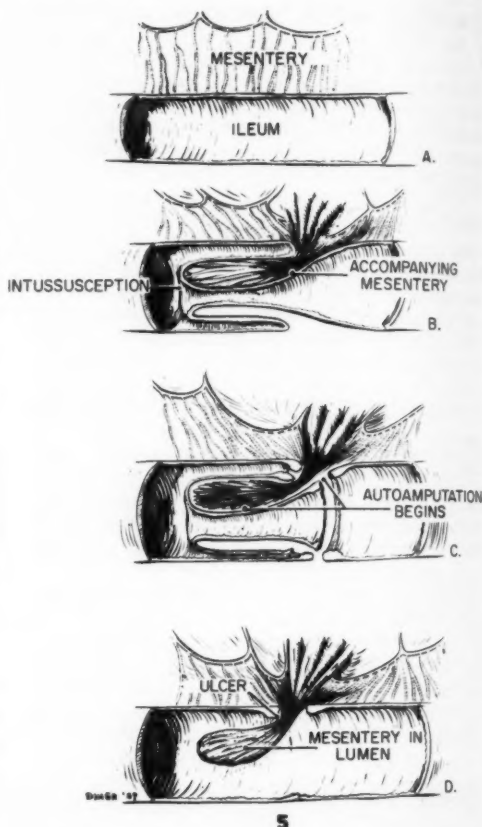
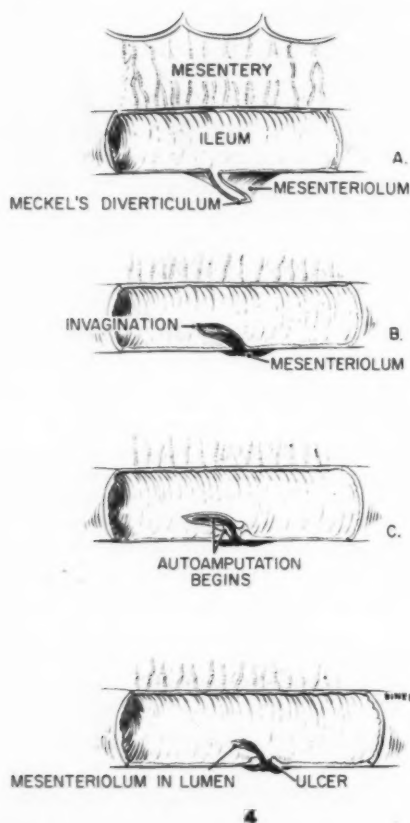


Fig. 4. Diagram illustrating how invagination of a Meckel's diverticulum (B) might undergo autoamputation of its wall (C) and leave its mesenteriolum within the lumen (D). Note that the mesenteriolum is relatively short and that it enters through an ulcer on the antimesenteric side of the ileum.

Fig. 5. Diagram illustrating how in intussusception (B) the intussusceptum might undergo autoamputation (C) and after autoanastomosis leave its mesentery within the lumen (D). Note that this mesentery may be of considerable length, depending upon the length of intestine sloughed, and that it enters through an ulcer on the mesenteric side of the ileum.

could slough. This would leave the mesenteriolum within the lumen, where it would protrude through an ulcer at the former base of the diverticulum (Fig. 4). This mesenteriolum would be relatively short, since Meckel's diverticula average approximately 4 to 8 cm. in length and rarely exceed 12 cm. On inspection, the base of the mesenteriolum would be found on the antimesenteric side of the lumen.

The third possibility would occur in conjunction with intussusception, followed by autoamputation and autoanastomosis, a well documented example of the body's

remarkable ability to heal itself (2, 3, 7, 8). Benson *et al* (2) present 2 cases which are interesting in that they represent the extremes of the effect on mesentery in such situations. In 1 instance a 33-cm. bowel segment was passed *per anum* with its mesentery attached; at operation the mesentery was found to be "sharply denuded to its roots." In the other case, the expelled loop, 112 cm. long, contained only bits of attached mesentery; at operation the mesentery from which the extruded loop had been detached was easily identified outside the bowel lumen. In

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this latter instance the mesentery must surely have pulled back from its position within the main bowel channel; had it, however, been so restricted in its movements that this retraction was impossible, then the detached mesentery would have remained within the lumen as the auto-amputation and anastomosis took place (Fig. 5). This mesenteric remnant may be of large size and it enters through an ulcer on the mesenteric side of the lumen.

SUMMARY AND CONCLUSIONS

We feel that this unique occurrence of mesentery within the distal ileum as a cause of obstruction is secondary to auto-amputation and autoanastomosis following intussusception. This opinion is supported by the fairly large size of the mesenteric remnant and the fact that it entered the ileum through an ulcer on the mesenteric side. The fact that the passage of the intussuscepted portion was not observed by our patient cannot be considered sufficient evidence to refute this hypothesis. In consideration of the location of this process in the distal ileum, a Meckel's diverticulum may well have initiated the intussusception; it is not possible for primary invagination and sloughing of the wall of the diverticulum to have been the pathogenesis in this case.

The presence of an isolated length of small bowel which contains barium within its lumen long after the main bulk of the barium has passed should lead one to consider that barium may have been deposited upon intraluminal mesentery, particularly when a history of intermittent or partial obstruction is present.

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SUMMARIO IN INTERLINGUA

Mesenterio Intraluminal Como Causa De Obstruction Del Intestino Tenue

Es describe un caso de intermittente obstruction del intestino tenue con un causa non previemente reportate in le litteratura, i.e., le inclusion de mesenterio intra le passage intestinal. Sex dies post le ingestion de barium, ansas del intestino tenue delineate per barium esseva ancora demonstrabile. Al operation il esseva trovate que le resectionate ileum contineva un resto de mesenterio, mesurante 15 per 8 cm, con barium adherente a su superficie. Le mesenterio habeva entrate in le intestino via ulcere a su latere mesenteric. Iste

inusual occurrentia es attribuite a auto-amputation e autoanastomosis post intussusception, probabilemente initiate in iste caso per un diverticulo de Meckel.

Le presentia de un isolate segmento de intestino tenue con barium intra le passage un longe tempore post que le plus grande parte del barium ingerite habeva passate debe inducer le examinante a considerar le possibilitate que barium ha essite deponite super mesenterio intra le passage, specialmente in casos con un historia de intermittente o de partial obstruction.

So-Called "Meigs' Syndrome" Associated with Benign and Malignant Ovarian Tumors¹

JOHN F. MOKROHISKY, M.D.²

FIBROMA OF THE ovary associated with ascites and hydrothorax was reported by Cullingworth in 1879, Demons in 1887, and Tait in 1892 (1, 2). Demons and Tait were the first to report that removal of the ovarian lesion would result in a cure. This clinical syndrome was definitely established in 1937, when Meigs and Cass reported a series of 7 cases of ovarian fibroma

less well known. Removal of the malignant ovarian tumor in such cases is also followed by disappearance of the effusions.

Schenck and Eis (4), in 1939, reported a case of papillary cystadenocarcinoma of the left ovary in which the ascites and hydrothorax disappeared after removal of the tumor, though they indicated that the malignant nature of the lesion was not

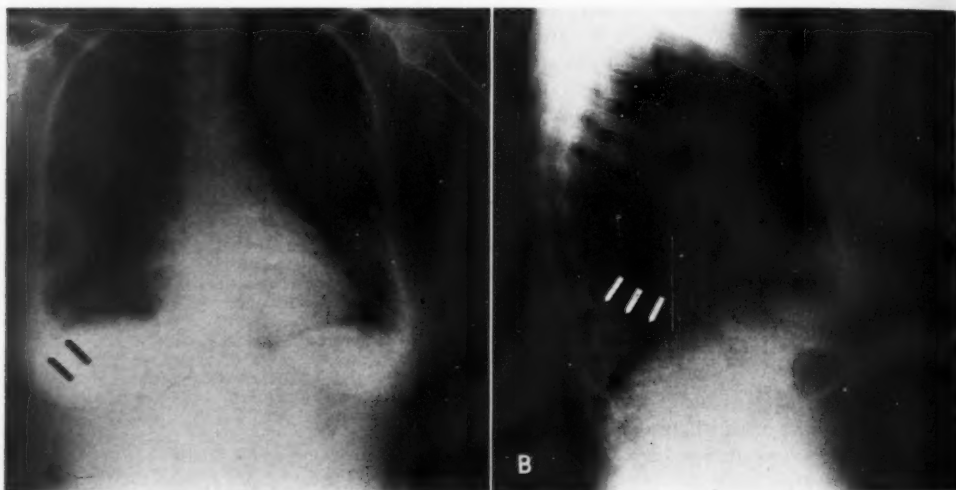


Fig. 1. Case I
A. Postero-anterior roentgenogram showing fluid in the right pleural cavity. Meigs' syndrome associated with fibroma of the ovary.
B. Lateral roentgenogram showing fluid in the right posterior costophrenic angle.

with ascites and hydrothorax in which the effusions disappeared following the removal of the tumor (3). Prior to this the association of ascites and hydrothorax with clinical evidence of a pelvic tumor had generally been considered evidence of an inoperable malignant lesion. Although it is now generally recognized that Meigs' syndrome appears with benign tumors of the ovary, especially fibroma, its association with malignant ovarian neoplasms is

in itself the cause of the fluid accumulations. Townsend (5) presented a case of bilateral multilocular papillary cystadenocarcinoma of the ovaries associated with ascites and pleural effusion in which the effusions disappeared and the patient recovered following operation. Dick, Spire and Worboys (6) described Meigs' syndrome associated with a Krukenberg tumor. Cases of Meigs' syndrome associated with malignant ovarian tumors have also been

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Fig. 2. Case I

A. Postero-anterior roentgenogram taken five months after removal of an ovarian fibroma. The right pleural effusion has disappeared.

B. Lateral roentgenogram showing clear posterior costophrenic angles. The right pleural effusion disappeared following removal of an ovarian fibroma.

reported by Beresford (1) in 1950, by Nelson and Dennison (7) in 1951, by Conway-Hughes (8) in 1951, and by Deacon (9) in 1954.

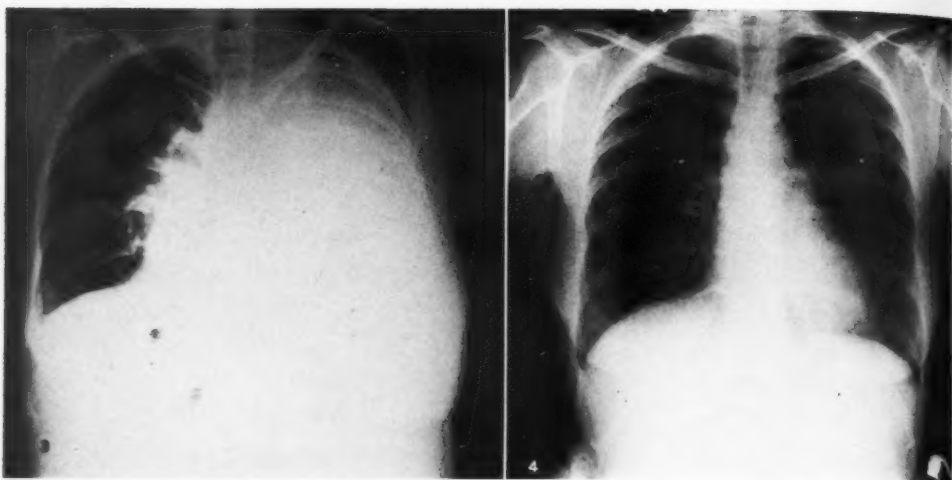
The syndrome as originally described by Meigs was limited to fibroma of the ovary. Recently he redefined this syndrome and included thecomas, granulosa-cell tumors, and Brenner tumors. These, according to Meigs, are the tumors with which this syndrome is most commonly associated. He did not include malignant ovarian tumors, though he did state that there is no question but that a malignant process may be responsible. His review of the literature (2) in 1954 showed 14 cases of malignant ovarian disease which resembled this syndrome. Most of these tumors were papillary cystadenocarcinomas, with one Krukenberg tumor, a fibrosarcoma of the ovary, and an adenocarcinoma of the round ligament. The same review disclosed 69 cases of the syndrome due to fibroma. Thirty-four other benign ovarian tumors, including thecomas, granulosa-cell tumors, Brenner tumors, teratoma, and various types of ovarian cyst, were reported in patients who had a

clinical course similar to that seen with Meigs' syndrome. It is of interest to note that, although Meigs' syndrome is generally well known, it is a relatively uncommon occurrence either with a benign or malignant tumor.

Of the following 2 cases, 1 was due to a fibroma of the ovary and the other to bilateral cystadenocarcinoma. In both cases the effusions disappeared following the removal of the tumor.

CASE I: A. C., a 59-year-old female, complained of soreness in the chest and lower abdomen. The past history was noncontributory.

Physical examination disclosed abdominal distention due to ascites and a large pelvic tumor extending above the level of the symphysis pubis. A small polyp was seen protruding from the cervix. Roentgenograms (Fig. 1) showed fluid in the right chest. One hundred and sixty cubic centimeters of fluid were aspirated from the right pleural cavity. Microscopic study failed to disclose any malignant cells in this fluid. At operation, a considerable amount of clear yellow fluid was present in the abdominal cavity. A large, firm tumor of the left ovary, about 9 cm. in diameter, was found and removed. The other ovary was atrophic. The pathologic diagnosis was fibroma of the left ovary. Follow-up chest films (Fig. 2) taken approximately five months following the removal of the fibroma disclosed absorption of the right pleural effusion.



Figs. 3 and 4. Case II

Fig. 3. Postero-anterior roentgenogram showing massive left pleural effusion associated with ascites and bilateral cystadenocarcinoma of the ovaries.

Fig. 4. Postero-anterior roentgenogram taken nine months after removal of bilateral cystadenocarcinomas of the ovaries. The left pleural effusion and ascites disappeared following removal of the tumors.

CASE II: H. B., a 52-year-old female, had a non-productive cough beginning two months prior to admission to the hospital. The cough persisted and became productive of foamy sputum. Progressive dyspnea and enlargement of the abdomen developed. She had had no previous illnesses. Her last menstrual period was three years earlier.

Physical examination revealed a dyspneic female with a pulse rate of 120 and a blood pressure of 120/80. On auscultation, diminished breath sounds were present over the left chest. A chest film at this time (Fig. 3) disclosed a massive pleural effusion on the left side. On three separate occasions 1,600 c.c., 1,500 c.c., and 2,600 c.c. of clear yellow fluid were removed from the left pleural cavity. Approximately 3,000 c.c. of clear yellow fluid was removed from the abdominal cavity. Neither the pleural nor the abdominal fluid was found to show any malignant cells on microscopic examination. Following the removal of the abdominal fluid, a pelvic mass could be palpated.

At operation a large multilocular cyst of the left ovary, some 9 cm. in diameter, was removed, as was a similar tumor of the right ovary, slightly smaller.

No metastatic peritoneal implants were seen at surgery. The pathological diagnosis was bilateral cystadenocarcinoma of the ovaries. Twelve days after surgery the patient was discharged. There was still some fluid in the left chest, which was diminishing in amount. There was no reaccumulation of fluid in the abdomen.

A follow-up chest film (Fig. 4), nine months after surgery, showed complete absorption of the fluid in

the left chest. Nine months later the patient was readmitted to the hospital because of recurrent disease in the pelvis. Surgery at this time disclosed recurrent ovarian tumor involving the rectum, sigmoid, and terminal ileum. An entero-enterostomy and a sigmoid colostomy were performed. The chest and abdomen continued to be free of fluid.

SUMMARY

Two cases of Meigs' syndrome have been presented. In one case the syndrome was associated with a fibroma of the ovary and in the other case with bilateral ovarian adenocarcinoma.

Meigs' syndrome is a relatively uncommon occurrence. It is well known that it may occur with fibroma of the ovary. It has also been reported with other benign ovarian tumors and occasionally with a malignant ovarian tumor.

Ascites and hydrothorax associated with a malignant ovarian tumor may not indicate secondary metastatic implants of the peritoneum and pleura. In some cases the effusion will disappear either for a number of months or permanently, following removal of the malignant ovarian tumor. It thus becomes important to recognize the benefits of surgical removal of the tumor, whether benign or malignant,

and not to regard the patient's condition as hopeless.

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SUMMARIO IN INTERLINGUA

Le Si-Appellate Syndrome De Meigs, Associate Con Benigne E Maligne Tumores Ovarian

Es presentate duo casos de syndrome de Meigs. In un del duo, le syndrome esseva associate con un fibroma del ovario e in le altere con bilateral adenocarcinoma ovarian.

Syndrome de Meigs es relativamente incommun. Es ben cognoscite que illo pote occurrer con fibroma del ovario. Illo ha etiam essite observate in association con altere benigne tumores ovarian e a vices con un maligne tumor ovarian.

Ascites e hydrothorace associate con un maligne tumor ovarian non indica necessariamente secundari implantas metastatic del peritoneo e del pleura. In certe casos le effusion dispare—pro le duration de alicun menses o permanentemente—post le elimination del maligne tumor ovarian. Ergo il es importante cognoscer le beneficios del excision chirurgic del tumor—si benigne o maligne—e non reguardar le condition del patiente como desperate.



Nonossifying Fibroma of Bone; Successive Lesions in the Same Tibial Metaphysis¹

MORTON H. LEONARD, M.D., MAYNARD S. HART, M.D., and
ROGER W. ECKFELDT, Jr., M.D.

ONE POSSIBLE explanation of nonossifying fibroma² of bone is that it represents a growth disturbance rather than a true neoplasm (1-3). The case reported here is believed to support this view.

J. W., female, age 7 years, was first seen on Feb. 1, 1954. On Jan. 29, she had fallen while roller skating. Subsequent to this, she complained of pain in the left leg and was unable to walk. Ex-

and homogeneous bone graft were done. At the time of operation, it was found that the distal third of the tibial cortex was thinned and that the area of radiotranslucency contained a grumous, yellowish material. This was reported by the pathologist as nonossifying fibroma of bone.

Gross examination of tissue removed for study revealed large and small irregular masses of yellowish-gray material of uniform consistency. The tissue was somewhat rubbery, but friable. Microscopic examination of multiple sections showed fibrous tissue of varying degrees of cellularity (Fig.



Fig. 1. Multiloculated area with fracture.

Fig. 2. Complete healing.

Fig. 3. New zone of involvement, distal to original lesion.

Fig. 4. Increased area of rarefaction.

amination revealed ecchymosis, tenderness, and swelling over the distal end of the left tibia. Radiographs revealed an infraction of the lateral tibial cortex through an oval, loculated area of radiotranslucency (Fig. 1). Skeletal survey revealed no other lesions.

The child was treated with a long leg cast until March 1, 1954. On that date, an excisional biopsy

5). About the margins of the tissue, the fibrocytic cells were small and compact and circumferentially arranged as though confined by the bony wall from which the tissue was removed. Other areas showed larger cells with relatively hyperchromic nuclei and delicate fibrillar cytoplasmic processes (Fig. 6). Mitoses were extremely rare. Multinucleated giant cells were occasionally noted (Fig. 7). In addition,

¹ From the Departments of Orthopaedic Surgery and Pathology, Hotel Dieu Sisters' Hospital, El Paso, Texas. Accepted for publication in September 1957.

² The term nonossifying fibroma is preferred to nonosteogenic fibroma of bone since this tumor is not derived from osteoblasts.

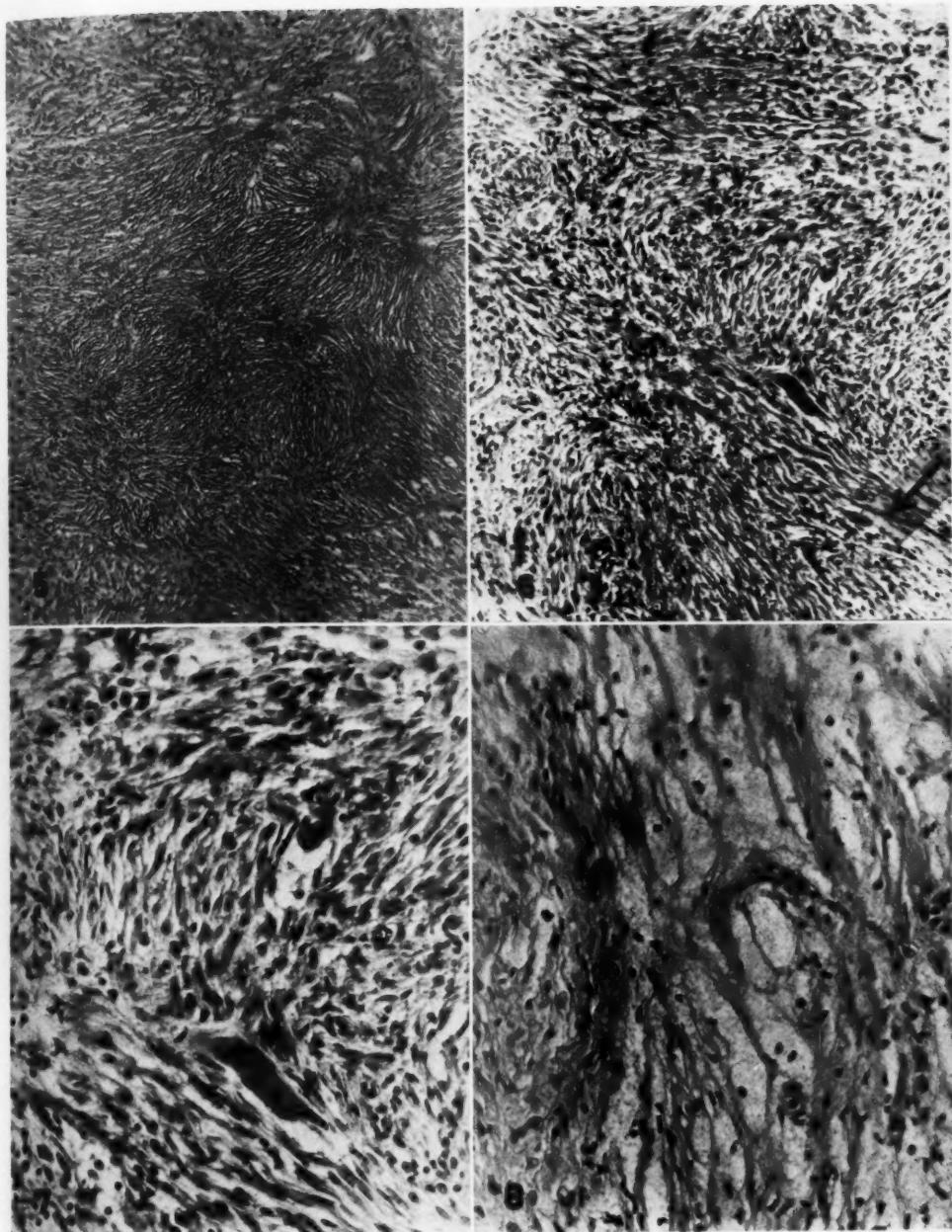


Fig. 5. Photomicrograph showing fairly uniform cellular pattern with no evidence of bone formation. Note mosaic pattern.

Fig. 6. Spindle-shaped nuclei predominate. Vascular slits are prominent.

Fig. 7. Fibrillar cytoplasmic processes. Poorly formed multinucleated giant cells.

Fig. 8. Xanthomatous-type cells.

there were areas of xanthomatous-type cells with small nuclei and abundant cytoplasm and with fairly distinct cytoplasmic outlines (Fig. 8). There were numerous vascular slits, but sheathed vessels were not prominent.

Postoperatively, the wound healed by first intention and a roentgenogram showed filling in of the radiotranslucent area (Fig. 2).

On May 16, 1955, approximately fourteen months postoperatively, roentgenograms showed complete healing of the operated area. However, a new zone, distal and distinct from the original, was seen (Fig. 3). This area increased in size, and by July 13, 1956, twenty-eight months postoperatively, threatened the structural integrity of the tibia (Fig. 4). The child was again operated upon on Oct. 25, 1956.

The second biopsy revealed tissue identical with the first specimen seen on March 2, 1954. The microscopic examination also showed an identical tissue pattern. In none of the sections was there evidence that the mesenchymal cells were forming bone spicules, and none of the sections showed enlarged haversian canals separated by compact fibrous stroma.

SUMMARY IN INTERLINGUA

Non-Ossificante Fibroma De Osso. Lesiones Successive In Le Mesme Metaphyse Tibial

Un puera de septe annos de etate cadeva e vulnerava su gamba sinistre. Roentgenogrammas revelava un infraction del cortice tibial lateral per un oval area loculate de translucencia. Un biopsia excisional monstrava tenuification del cortice e resultava in un diagnose de non-ossificante fibroma de osso. Le curation progrededa per prime intention, e le area radioluciente se replenava normalmente. Tamen, dece-quatro menses plus tarde,

un secunde zona de translucencia, distal al prime e distincte ab illo, esseva demonstrate roentgenologicamente. Le biopsia monstrava un tableau pathologic exactemente simile a illo del previe lesion.

Es opinata que le occurrentia de iste duo successive lesiones de non-ossificante fibroma de osso in le mesme metaphyse tibial supporta le these que le condition representa un disturbance de crescentia plus tosto que un neoplasma.

SUMMARY

The occurrence of two distinct successive lesions of nonossifying fibroma of bone at the same tibial metaphysis is presented as evidence that nonossifying fibroma of bone is a growth disturbance.

ACKNOWLEDGMENT: Photomicrographs of the tissue sections were made by the Medical Illustration Section, William Beaumont Army Hospital. The microscopic slides were reviewed by Major Robert Kellenburger, pathologist at that hospital.

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LogEtronic Simplification in Simulated Color Radiography¹

LOUIS J. BONANN, M.D.,² and ANDREW H. DOWDY, M.D.³

THE RECENT introduction of the LogEtronic Contact Printer has provided a means of ready simplification in the preparation of simulated color roentgenograms. As indicated in our initial report on simulated color roentgenography (1), it is necessary first to obtain a black and white negative of the roentgenogram selected for color reproduction. From this negative an exposure is made by contact or enlargement, usually the latter, onto Matrix or Pan-Matrix film. The exposed film is then processed, by the steps specified in Table I, to produce a gelatin relief image for the addition of the Flexichrome colors as desired.

The quality of the original negative is one of the most important single factors in the success of the final color preparation. A good original negative must contain and transmit all of the definition desired for proper form and value in the final result. This result is a color roentgenogram that realistically represents the selected roentgenogram as naturally as possible.

The routine visual adaptation procedures in the darkroom usually cause an accentuation of shadows visible to the eye at the exposure of the photographic negative. Consequently, an unequal or uneven distribution of light over the preparation is much more apparent in the reproduction than in the original. To eliminate and counteract these deficiencies, the preparation is usually carefully lighted to lower subject contrast than required in the final reproduction. The great difficulty is to keep even lighting over the entire preparation. The necessity for this low-contrast lighting is accentuated by variable areas of contrast in the original roentgenogram. The important point is not to permit areas to become too dark to show detail

TABLE I: SUMMARY OF PROCESSING STEPS FOR MATRIX COLOR PREPARATIONS (1, 2)

Step	Solution	Temperature (approx.)	Procedure	Time (min.)
1.	Water	68° F.	Presoak (elective)	1
2.	Matrix film developer	68° F.	Mix 1 part solution A and 2 parts solution B just before use. Continuous agitation	2
3.	Water	68° F.	Wash and rinse film	1/2
4.	Matrix film fixer	68° F.	Continuous agitation	2
5.	Hot water	120° F.	Rinse in 3 complete changes	2
6.	Cold water	30° F.	Immerse in water; lift and drain 3 times	1/2
7.	Flexichrome modeling agent	68° F.	Dye to completion	3
8.	Acetic acid 2%	68° F.	Rinse in 2 changes of solution	2
9.			Dry	
Total elapsed time				13

After drying proceed with dye coloring.

Exposure made by contact through base of Matrix film from the photographic negative of the selected roentgenogram.

and yet not too accentuated to bring about artificiality (2).

One solution to this problem is the new method of LogEtronic photographic printing, which reproduces accurately at mid-scale the most useful portions of the density range of the negative. The LogEtronic process utilizes the device of "dodging." It involves a completely automatic one-step, one-material operation as outlined in the Instruction Manual (3). As one becomes familiar with the use of the printer, he will be able to produce high-quality negatives with a constancy which is desirable for routine purposes.

In an excellent article St. John and Craig have described the basic principle of the

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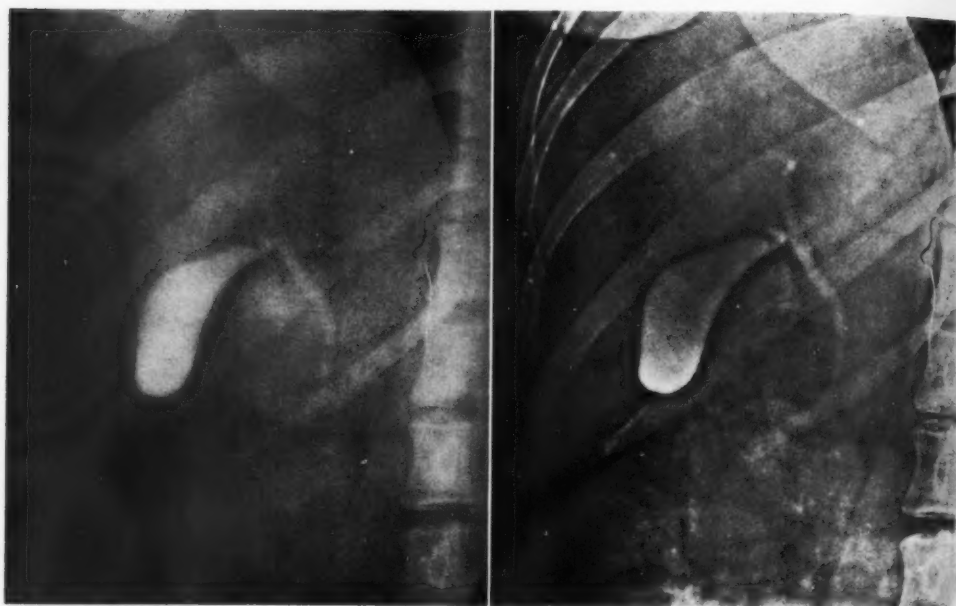


Fig. 1. A. Conventional reproduction. Ordinary photocopy print of oral cholecystogram. B. LogEgram from same original film, demonstrating improvement in detail contrast. Note collection of opaque medium in duodenum.

LogEtronic Contact Printer and have outlined in detail its operation (4). They illustrate the improved photographic effect obtained by "dodging" in simultaneously increasing and decreasing contrast. In an ordinary print highlight and shadowy regions are printed at opposite extremes of the density scale, and detail merges with the background. The LogEtronic process "dodges" these two regions and approximates them to average density; gross contrast is reduced, while detail contrast is increased, resulting in better reproduction and improved visualization (Fig. 1).

PROCEDURE

The exact operation of the LogEtron is almost automatic and is described fully, step by step in the Instruction Manual (3). In summary, the general procedure for obtaining a negative for color preparation is as follows:

The selected roentgenogram is exposed directly in contact with and through the base of Matrix (or Pan-Matrix) film in the LogEtron. After insertion of the roent-

genogram and Matrix film the Exposure Index Dial is set, in accordance with the instructions, for the emulsion speed for the film used and the photo-processing conditions. Our final working technic calls for setting the dial at 100, with the multiplier switch set at *factor* $\times 10$. This utilizes an increased exposure index of 100×10 or 1,000. The dodging factor switch is set at the most desirable position, usually position 4 for the complete dodging effect. These controls, once set, usually remain fixed unless the type of work is altered or extreme variables in new negatives are encountered. The *platen* of the instrument is lowered to start the exposure, which is automatically controlled. Its termination is indicated by the "shutting off" of the *print indicator light* with an audible click. Preparations as small as 4×5 and as large as 14×17 inches can be obtained without readjustment of the instrument. The exposed Matrix film is processed in accordance with the procedure outlined in Table I.

This process produces a "reversal" for

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color preparation. This is of no consequence, however, since the added color determines the visual characteristics of the completed film. If a direct duplication of the selected roentgenogram is desired, the preparation of an intermediate "positive" will be the only additional step. As already indicated, the preparation of such an intermediate is likewise simplified by the LogEtronic process; the required time is reduced and one step in the photographic procedure is eliminated. The results have been adaptable to our techniques and the sensitized materials available to us, but will vary in accordance with the circumstances encountered and the basic radiographic processes, as well as the photographic duplication procedures available in other departments.

SUMMARY

The LogEtronic procedure has simplified the preparation of simulated color roentgenograms. Development of the required negatives of the selected roentgenograms is automatic, and standardized

facsimile duplication is attained. The process is shortened and numerous factors of variability are eliminated. The revised and modified procedure is outlined and supplemented by tabular instructions.

Familiarity with the technic and operation of the LogEtronic will possibly encourage the preparation and use of "color roentgenograms" and perhaps permit more general use of these teaching aids where the instrument can be made available. Numerous potential applications beyond the realm of color preparations may be disclosed.

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SUMMARIO IN INTERLINGUA

Simplification De Simulate Chromoroentgenographia Per Medio Del LogEtronic

Le uso del LogEtronic ha simplicite le preparation de simulate chromoroentgenogrammas. Le disveloppamento del requirite negativas del roentgenogrammas seligite es automatic, e le duplication de facsimiles standard deveni possibile. Le processo es plus rapide, e numerose factores de variabilitate es eliminate. Le procedimento in su forma revidite e modificate

es delineate e supplementate per instructiones tabular. Familiaritate con le operation del LogEtronic va incoragiar le preparation e le uso de chromoroentgenogrammas e permitir un uso plus general de iste adjuta de instruction in institutiones ubi le LogEtronic es disponibile. Numerose applicationes potential, foras del area de preparationes in color, pote esser expectate.

EDITORIAL

Bronchial Adenoma

The great attention which has been properly focused on the diagnosis and treatment of bronchogenic carcinoma in recent years has yielded, as a by-product, much valuable information on various other tumors and tumor-like lesions of the lungs. One of these, whose characteristics have been brought into better perspective, is bronchial adenoma. While this tumor has at various times been termed benign, potentially malignant, or malignant, it is well known that its prognosis is far different than that of bronchogenic carcinoma.

Moersch and McDonald (1) believe that bronchial adenoma should be considered a carcinoma of low-grade malignancy capable of metastasizing. Knesevitch, McCormack, Effler, and Groves (2), on the other hand, found no evidence of metastasis among 21 cases, but they do not include the cylindromas of the trachea and bronchi in their classification of bronchial adenomas.

The exact origin of these tumors has been somewhat controversial, but most workers now agree that they arise from the duct epithelium of the bronchial mucous glands. Two types are generally accepted, the carcinoids and the cylindromas. The carcinoid type is sometimes spoken of as benign in character, but enough instances of aggressive growth and metastasis have been reported to indicate that in many instances it shows at least a low-grade malignancy. Soutter, Sniffen, and Robbins (3), in a study of 56 carcinoid adenomas, found mitoses in 6 cases, microscopic evidence of penetration through the capsule in 25 of 30 encapsulated tumors, and secondary deposits in adjacent lymph nodes in 3 patients. Blood vessels were not invaded in any of these cases. In

most reported series where metastasis has occurred, it has been limited to the regional lymph nodes in a majority of cases, but secondary involvement of the liver, lungs, skeletal system, and viscera has also been recorded.

Cylindromas occur most commonly in the trachea or adjacent major bronchi. Grossly, they may resemble adenomas of the carcinoid type, but they are usually more invasive; they are not encapsulated, and mitoses are more common than in the carcinoid tumors. They appear to metastasize slowly but pursue a gradually progressive course and require complete removal if a cure is to be effected. If this group is to be included with the adenomas, we are well advised to regard these tumors as of low-grade malignancy rather than to designate them as benign.

Because of the slow growth of bronchial adenomas, symptoms may be slight and extend over a long period of time. If the tumor is situated peripherally and is circumscribed, the patient may be entirely asymptomatic. Good and Harrington (4), in a series of 100 cases, found 17 in which there had been no respiratory symptoms up to the time of roentgen discovery of the tumor. In 77 of their patients there was evidence of bronchial obstruction, with the usual symptomatology. Cough is often persistent and may or may not be productive. Hemoptysis is of frequent occurrence and may appear and disappear without any previous physical effort. One of the prominent and often baffling aspects in the history of these patients is pulmonary suppuration secondary to bronchial obstruction. This may vary from frequent bouts of pneumonia to severe saccular bronchiectasis and pulmonary abscess with discharge of copious

amounts of pus. McBurney, Clagett, and McDonald (5) state that approximately 55 to 60 per cent of patients with obstructive adenoma will have suppuration, which adds greatly to the difficulty of surgical resection. In their series deaths from suppuration greatly outnumbered deaths from metastasis.

The roentgen findings vary according to the location and size of the tumor. In peripherally located adenomas roentgen changes may be absent or limited to a localized mass unaccompanied by secondary pulmonary changes. In their series of 100 cases, Good and Harrington found roentgen evidence of an uncomplicated mass in the lung in 23. These masses varied in size from 1.5 cm. to 8 cm. in diameter. Lowry and Rigler (6) call attention to atelectasis secondary to bronchial obstruction and to the "drowned lung" phenomenon which commonly accompanies it. They feel that bronchiectasis localized to one lobe should always suggest the possibility of bronchial adenoma. They suggest bronchography for localization of the obstruction and demonstration of the associated bronchiectasis. The delineation of a "cap-shaped" defect, due to layering of the bronchographic medium over the surface of the tumor, lends added weight to the diagnosis. These workers have been able in some cases, with the use of body-section roentgenography, to visualize the tumor directly as a rounded, sharply defined, dense shadow in contrast to the air in the bronchus. It must be remembered, however, that the final diagnosis depends on the roentgen changes taken in conjunction with the history and the microscopic examination of the biopsy specimen, which is usually obtained by bronchoscopy. In 19 of the series of 21 patients studied by Kneesevitch *et al.*, bronchoscopic examination was done and positive findings were reported in 15. In 12 patients the biopsies were positive for bronchial adenoma. Pro-

fuse bleeding often follows bronchoscopy and biopsy.

The most commonly recommended method of treatment of bronchial adenoma at present is pulmonary resection. For peripherally located tumors a simple lobectomy is usually the procedure of choice and carries a low mortality rate. In those cases where the tumor is located in the main bronchus, pneumonectomy is usually necessary, although occasionally small tumors can be removed electrosurgically through the bronchoscope. Kneesevitch *et al.* performed lobectomy in 11 cases and pneumonectomy in 8, local bronchoscopic removal in 1 case, and bronchotomy in 1. All their patients have remained well.

It is evident that bronchial adenomas are slow-growing tumors of a low grade of malignancy. If peripherally located, they may be asymptomatic; centrally located tumors, on the other hand, produce obstructive signs, with atelectasis and sometimes bronchiectasis. It is not safe to consider them as benign. The fact that, when these tumors develop aggressive growth, they usually invade local structures, indicates a favorable prognosis if wide resection is performed. In those cases where metastasis has occurred, the prognosis follows the usual pattern of metastasizing malignant tumors.

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The Lawrence Reynolds Library

Not to everyone is it given, in addition to establishing himself as a leader in his chosen field, to pass on to his immediate successors the hard-won knowledge of the past and to provide inspiration for generations yet to come. It is with particular satisfaction, therefore, that we recognize the achievement of our colleague, Dr. Lawrence Reynolds, in the assembly of an outstanding medical library and its presentation to a university medical center, where students of the medical art may become acquainted at first hand with some of their rich heritage. We are indebted to Dr. Traian Leucutia, long associated with Dr. Reynolds, for the following account of this notable gift. H.P.D.

On Sunday afternoon, Feb. 2, 1958, The Lawrence Reynolds Library was dedicated with impressive ceremonies at the University of Alabama Medical Center in Birmingham. This Library, which contains one of the world's finest and most valuable private medical collections, was donated to his native state and its university by Dr. Lawrence Reynolds, Editor of the *American Journal of Roentgenology, Radium Therapy and Nuclear Medicine*, who spent a lifetime acquiring it.

This rare collection is housed in a special wing which the University had built as an extension to its new Medical Center Library. It consists of some 6,000 pieces, including original manuscripts, autographed letters, and old medical texts, some of them dating back to the fifteenth and sixteenth centuries, representing the highest achievement in Renaissance printing.

The section of original manuscripts includes, among others, the fourteenth-century manuscripts of Arnoldus de Villa Nova, entitled *Regimen Sanitatis ad regem Aragonum*, and John of Toledo's *Dietarium*; the original manuscript of the article on *The Stereoscope and Stereograph* contributed to the *Atlantic Monthly* in June 1859 by Oliver Wendell Holmes; and, of more recent date, the address on *The Discovery of Radium* delivered by Mme. Marie Curie (Sklodowska) on May 14, 1921, at Vassar College, with an autographed photograph.

The letter section contains all the correspondence of Louis Pasteur with the mayor of the village on silkworm disease, consisting of 20 holograph letters of Pasteur (1866-89), 8 letters in the hand of Mme.

Pasteur, and 2 unpublished photographs; the letter of Louis Pasteur to Monsieur Marchand, dated Aug. 12, 1881, on rabies; and other items from the pen of this giant of science who revolutionized both industry and medicine by applying laboratory knowledge to fight disease. There are also signed letters, with typed transcripts, by Sir William Osler to his "good friend Ned Milburn" (1865-1919); two original letters from Wilhelm Conrad Röntgen and Frau Röntgen to Louis Grauel; and others.

Of the large section of medical books of the sixteenth and seventeenth centuries, three groups deserve special mention. It is now generally agreed that the foundations of modern medicine were laid down in this period by three epoch-making contributions. In 1543 the first complete textbook on human anatomy was published by Andreas Vesalius, entitled *De humani corporis fabrica librorum epitome*, Johannes Oporinus, Basel. This book, as well as Vesalius' other contributions, was illustrated with magnificent drawings by van Calcar, a pupil of Titian. The Library contains not only Vesalius' textbook in its first edition but also other publications of this truly great anatomist, several later editions of his works, and a group of books on the contributions of his teacher, Sylvius, who from a friend turned into a bitter foe, of Fallopius and Eustachius, his successors, and of other famed anatomists of the period, most of whom became "Vesalius converts."

This study of the "fabric" of the human body based on pure research was soon followed by an interest, based on similar

ground, in the functions of the body. Among those who pursued such a course was Andreas Caesalpinus, who, in his *Peripateticarum Questionum Libri Quinque* published in Venice in 1571, began speaking of the "circulation" of the blood. His bold theory, however, was not supported by experimental proof and thus he had no influence on his contemporaries. Later, in 1628, at the book fair in Frankfurt, a slender, poorly printed volume was displayed by William Harvey, *Exercitatio anatomica de motu cordis et sanguinis animalibus*, presenting for the first time experimental proof that the heart acts as a pump causing circulation of the blood throughout the body. The books of Caesalpinus and Harvey and 12 other texts and facsimiles of Harvey's book published in different countries form the nucleus of the second group of works, which contains also contributions of Fabricius Hieronymus of Aquapendente, Harvey's teacher, *De venarum ostiolis*; of Francis Bacon, one of Harvey's most notable patients, *Instauratio magna (Novum organum)*; Harvey's second great work *Exercitationes de Generatione Animalium* (1651) on embryology, and many similarly rare items.

The third group of collections of this period is highlighted by the works of Ambroise Paré, the greatest surgeon of the sixteenth century. Paré based his practical surgery on the new concepts expounded in Vesalius' *De Fabrica* and, after being able to conquer the prejudices of the time, introduced sound methods for the treatment of a rather significant number of lesions. His influence on contemporaries and successors for the next two centuries is amply reflected by the many contributions comprising this group.

In 1600, William Gilbert published his epochal work *De magnete, magneticisque corporibus et de magno magnete tellure; physiologia noua, plurimis argumentis experimentis demonstrata*, establishing the basis for the formidable sciences of magnetism and electricity which were to develop. Progress was rather slow until the middle of the eighteenth century, when

Benjamin Franklin, in his extensive *Experiments and Observations on Electricity Made at Philadelphia*, defined "positive" and "negative" electricity and considered, among many other things, the possibility of curing palsy by electric shock. In 1786, Luigi Galvani discovered "animal electricity." This discovery was followed in rapid succession by Alessandro Volta's construction of the first electric pile, as communicated in a letter to the Rt. Hon. Sir Joseph Banks (1800); by Hans Christian Oersted's *Experimenta circa effectum conflictus electrici in acum magneticum* (1820), establishing a link between electricity and magnetism; by André Marie Ampère's *Mémoire présenté à l'Académie Royale des Sciences sur l'action mutuelle entre deux courants électriques* (1820), describing the mutual effect of two electric currents; and by G. S. Ohm's work in 1827, formulating the relationship between voltage, amperage, and resistance. Then in 1837, Faraday and Henry discovered electromagnetic induction. These important works and many others in the chain of development of the two sciences form an eminent part of the Reynolds Library and constitute a monumental introduction to the vast collection of contemporary literature in the field of radiology.

Among the more recent contributions are many rare works from other branches of medicine, as exemplified by some forty writings from the pen of Sir William Osler, the great physician of modern times; an almost complete set of Harveian Orations, beginning in 1865; an extensive compilation of Nobel Prize Papers; and others.

These are but brief heuristic glimpses into a magnificent library. The dedication plaque that graces the entrance reads: "Each time one of you reaps from the great minds of the past the desire for finer achievement in your profession and nobler development of your own character, The Reynolds Library will have been rededicated." In the ancient words of Terentianus Maurus, spoken in 1286, *Pro captu lectoris habent sua fata libelli*.

TRAIAN LEUCUTIA, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN COLLEGE OF RADIOLOGY

At its Thirty-fifth Annual Meeting, Feb. 7, 1958, the American College of Radiology elected the following officers: President, Vincent W. Archer, M.D., Charlottesville, Va.; Vice-President, Ivan M. Woolley, M.D., Portland, Ore. Elected to four-year terms on the Board of Chancellors were Harold O. Peterson, M.D., St. Paul, Minn., and John A. Evans, M.D., New York, N.Y.

IDAHO STATE RADIOLOGICAL SOCIETY

The Idaho State Radiological Society, organized in 1950, recently elected the following officers: President, Donald D. McRoberts, M.D., Lewiston; Vice-President, Alfred Stone, M.D., Boise; Secretary-Treasurer, Charles R. McWilliams, M.D., Twin Falls. The next meeting will be held May 31, 1958, at Pocatello.

Attempts are being made by the Society to clarify and stabilize the hospital-radiologist relationship under the Medical Practice Act of the State of Idaho, as well as to promote the cause of better radiologic practice in the State.

KANSAS RADIOLOGICAL SOCIETY

The Kansas Radiological Society has elected the following officers for the ensuing year: G. Sherman Ripley, Jr., M.D., Salina, President; Louis G. Allen, M.D., Kansas City, Vice-President; James R. Stark, M.D., 3244 E. Douglas St., Wichita 8, Secretary; Charles M. White, M.D., Wichita, Councilor to the American College of Radiology; A. M. Cherner, M.D., Hays, Alternate Councilor.

CANADIAN ASSOCIATION OF RADIOLOGISTS

At the twenty-first annual meeting of the Canadian Association of Radiologists, held recently in London, Ontario, the following officers were elected to serve for the ensuing year: President, Dr. A. R. McGee; Vice-President, Dr. E. M. Crawford; Honorary Secretary-Treasurer, Dr. Guillaume Gill; Associate Honorary Secretary-Treasurer, Dr. Robert G. Fraser. The General Secretary of the Association is Miss G. A. Mollison, 1555 Summerhill Ave., Montreal 25, Que.

GREATER ST. LOUIS RADIOLOGICAL SOCIETY

The Greater St. Louis Radiological Society recently elected the following new officers: President,

Sam J. Merenda, M.D.; Vice-President, Thomas F. Maher, M.D.; Secretary-Treasurer, Charles J. Cherre, M.D., 462 North Taylor, St. Louis 8.

TEXAS RADIOLOGICAL SOCIETY

Newly elected officers of the Texas Radiological Society are: President, Dr. R. F. Wertz, Amarillo; President Elect, Dr. H. C. Sehested, Fort Worth; First Vice-President, Dr. D. von Briesen, El Paso; Second Vice-President, Dr. Benjamin Dubilier, Austin; Secretary-Treasurer, Dr. J. E. Miller, 3500 Gaston Ave., Dallas 10; Historian, Dr. Thomas B. Bond, Fort Worth; North District Councilor, Dr. Glenn Carlson, Dallas, with Dr. R. P. O'Bannon, Fort Worth, as Alternate; Central District Councilor, Dr. D. B. Jones, San Antonio, with Dr. F. E. O'Neill, San Antonio, as Alternate; South District Councilor, Dr. P. E. Wigby, Houston, with Dr. W. J. Stork, San Antonio, as Alternate.

The next meeting of the Society will be held at the Statler-Hilton Hotel, Dallas, Jan. 30-31, 1959.

SOCIETY OF NUCLEAR MEDICINE

The Society of Nuclear Medicine will hold its Fifth Annual Meeting in Los Angeles, Calif., June 19-21, 1958. The formal sessions will include four instructional courses to be offered on two days, dealing with thyroid-uptake calibration, measurement of mixtures of radioisotopes, measurement of total exchangeable electrolyte, and medical application of a five-watt aerogel reactor. In addition to the scientific sessions, there will be tours of Los Angeles nuclear medical facilities, a session on the training of physicians in the use of radioisotopes, and scientific and commercial exhibits.

Further information is available from the secretary of the Society, Dr. Robert W. Lackey, 452 Metropolitan Building, Denver, Colo., or from the program chairman, Dr. Granvil C. Kyker, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.

FIRST ANNUAL SYMPOSIUM ON CINEFLUOROGRAPHY

The Department of Radiology, University of Rochester School of Medicine and Dentistry, is sponsoring the first Annual Symposium on Cinefluorography to be held at the Strong Memorial Hospital, Rochester 20, N. Y., on Nov. 14-15, 1958, just prior to the annual meeting of the Radiological Society of North America in Chicago. Dr. Theodore A. Tristan is Program Chairman.

All inquiries concerning the Symposium should be addressed to Dr. George H. Ramsey, Department of Radiology, Strong Memorial Hospital.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE ALIMENTARY TRACT OF THE RUMINANT. By DAVID BENZIE and A. T. PHILLIPSON, M.A., Ph.D., M.R.C.V.S., F.R.S.E., The Rowett Research Institute, Bucksburn, Aberdeenshire. A volume of 24 text pages, with 54 plates and 4 tables. Published by Charles C Thomas, Springfield, Ill., 1957. Price \$5.50.

PROGRESS IN PEACEFUL USES OF ATOMIC ENERGY, July-December 1957. By UNITED STATES ATOMIC ENERGY COMMISSION. A paper-bound volume of 464 pages, with figures, charts, and tables. Published by the United States Government Printing Office, Washington, D. C., 1958. For sale by the Superintendent of Documents, U. S. Government Printing Office. Price \$1.25.

ERNIE E RELAXATIO DEL DIAFRAMMA. By G. BALDINI, L. FERRI, and L. RONCORONI. Preface by Prof. Arduino Ratti. A volume of 154 pages, with 52 roentgenograms and 2 diagrams. Published by Casa Editrice Renzo Cortina, Viale Golgi 14, Pavia, Italy, 1957. Price 2500 lire.

RADIUM-ISODOSEN: DIE RADIUMDOSIERUNG IN "R." By DR. MED. AUGUST VERHAGEN, Oberarzt an der Städt. Frauenklinik Essen (Ruhr). With a Foreword by Prof. Dr. K. Nordmeyer, Chefarzt der Städt. Frauenklinik Essen (Ruhr). [In German and English.] A volume of 104 pages, with 39 charts, 1 photograph, and 3 tables. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 19.50 (\$4.65).

Book Reviews

ROENTGEN DIAGNOSIS OF ABDOMINAL TUMORS IN CHILDHOOD. By CHARLES M. NICE, JR., M.D., Ph.D., ALEXANDER R. MARGULIS, M.D., and LEO G. RIGLER, M.D., all from the Department of Radiology, University of Minnesota Medical School, Minneapolis, Minnesota. A volume of 76 pages, with 89 roentgenograms, 1 photograph, and 5 diagrams. Published by Charles C Thomas, Springfield, Ill., 1957. Price \$4.00.

This small monograph in the field of pediatric roentgenology is devoted to the thesis that the roentgen examination may not only give the anatomical localization of an abdominal tumor but

may assist in rendering a specific preoperative diagnosis. One chapter is devoted to the various methods of roentgen examination, with stress on the value of plain roentgenograms in the various planes.

The classification of the abdominal tumors of childhood is based on topography, and the text is organized along these lines, with chapters on Masses in the Region of the Liver; Other Intra-peritoneal Masses; Renal and Adrenal Masses; Other Extra-peritoneal Masses. The various tumors which occur in these areas are described and their clinical and diagnostic features are set forth.

This monograph will appeal to radiologists, pediatricians, and pediatric surgeons. Though brief, it contains a wealth of valuable information.

THE YEAR BOOK OF RADIOLOGY (1957-1958 YEAR BOOK SERIES, RADIOLOGIC DIAGNOSIS. Edited by JOHN FLOYD HOLT, M.D., Professor, Department of Radiology, University of Michigan, and FRED JENNER HODGES, M.D., Professor and Chairman, Department of Radiology, University of Michigan. **RADIATION THERAPY.** Edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City, and MORTON M. KLIGERMAN, M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University; Associate Attending Radiologist, Presbyterian Hospital, New York City. A volume of 446 pages, with 335 figures. Published by The Year Book Publishers, Inc., Chicago, Ill., 1957. Price \$10.00.

The Yearbook of Radiology again appears under the editorship of Drs. John F. Holt, Fred J. Hodges, Harold W. Jacox, and Morton M. Kligerman, names which assure its continued excellence. As was to be expected, the potential dangers of radiation, brought for the first time to the attention of a large lay public in recent months—though long familiar to radiologists—are considered in both the Diagnostic and Therapy Sections of the *Yearbook*. Two quotations serve to express the advised opinions as to these hazards.

Drs. Holt and Hodges: "Pending final analysis and evaluation of all opinions which will be expressed and documented, radiology can well be proud of its record of achievement to date in the direction of radiation safety measures."

Drs. Jacox and Kligerman: "What has appeared is largely composed of extrapolations, honest misunderstandings and, at times, data in which undetermined or hidden bases existed. It is hoped that before more official or unofficial pronouncements are made on this subject, the biologic scientists will have an opportunity to obtain the necessary facts on this important matter. The confusion between the exposure to fall-out radiation of large population groups and the ill patient who must have diagnostic or therapeutic radiation is quite unfortunate."

The text continues, as in former years, to afford a comprehensive overall view of the progress of radiology in the period covered (June 1956-June 1957).

THE PHYSICIAN-WRITER'S BOOK. TRICKS OF THE TRADE OF MEDICAL WRITING. By RICHARD M. HEWITT, A.M., M.D., Senior Consultant, Section of Publications, the Mayo Clinic; Associate Professor of Medical Literature, the Mayo Foundation, Graduate School, University of Minnesota. A volume of 416 pages, with 37 figures and numerous tables. Published by W. B. Saunders Co., Philadelphia & London, 1957. Price \$9.00.

The importance of the written word to the student and practitioner of medicine is attested by the multiplicity of journals, monographs, and full-fledged texts that occupy the shelves of medical libraries of even moderate proportions. The pitfalls inherent in medical writing are less generally known, but to the editor with a desk piled high with manuscripts they are an ever present reality and challenge. Though Dr. Hewitt has not addressed his book to this group, they cannot but profit by

what he has to say to "the inexperienced, inexpert, occasional physician-writer," with whose problems he is specifically concerned.

An initial consideration of the whole article or book—covering such matters as titles, general content, arrangement of the text, etc.—is followed by sections on the paragraph, the sentence, and finally the words themselves through which the writer would convey his meaning. There is a section on tables and illustrations, which even the more experienced writer—and incidentally the typist who is entrusted with the tabulations, the artist, and the photographer—may read with profit. The more mechanical preparation of the copy for the publisher, details as to copyright, and the ethics involved in medical publication are also taken up. Finally, a variety of points are covered in twenty-one brief appendixes which include, along with excellent positive advice, some equally illuminating "horrible examples."

The book is written in an easy, almost conversational style, with no trace of pedantry or academic superiority. The reader will feel at once on terms of friendliness with the writer and will accept gratefully the fruit of his long experience with writers and physicians.



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IN MEMORIAM

FREDERICK HASE RODENBAUGH, M.D.
1891-1957

Dr. Frederick Hase Rodenbaugh of San Francisco, a member of the Radiological Society of North America since 1920, died on Oct. 30, 1957.

Dr. Rodenbaugh was graduated from the Medical School of St. Louis University in the year 1913. Not long thereafter he saw service in World War I and then entered the practice of radiology in San Francisco at St. Francis Hospital, where he was associated with Dr. Irving Ingber and the late Dr. Robert Kile. A colorful figure, he took an active part in the proceedings of the hospital staff, in the development of radiology in the San Francisco area, and in the activities of a distinguished club composed of artists, painters, poets, and other professional persons.

About 1927 Dr. Rodenbaugh decided to continue his radiological practice at 490 Post St., San Francisco, where a large medical office building was then in course of erection. There for many years he conducted an active practice in conjunction with Drs. Ingber and Kile and later with Drs. Petrilli and Duvall. He was associated also with Franklin Hospital and Mary's Help Hospital of San Francisco.

Beside his membership in the Radiological Society of North America, Dr. Rodenbaugh was a member of the American Roentgen Ray Society, the American Radium Society, and the American College of Radiology. In 1946 he was with the Medical Radiological Task Force at the Bikini atomic bomb tests. In 1957 he showed evidence of a lesion in the left lower lobe, and, despite surgery and radiotherapy, succumbed to carcinoma of the lung. He is survived by his widow, Charlotte, a son Frederick of San Jose, and three daughters, Mrs. Antonio Vallerino and Mrs. Carl Carlson of Atherton and Mrs. John Schaupp of San Francisco. He will be missed by his numerous colleagues and friends both in this city and elsewhere.

L. H. GARLAND, M.B.

DR. ARTUR SCHÜLLER

Dr. Artur Schüller died Oct. 31, 1957, in Heidelberg, near Melbourne, Australia, at the age of 83. To the younger among us, Schüller is known from Hand-Schüller-Christian disease, eosinophilic granuloma. The older of us recall that Schüller stood at the cradle of neuroroentgenology and was one of its foremost pioneers.

Artur Schüller was born in 1874 in the city of Brünn, at that time in Old Austria, now Brno, Czechoslovakia. He was the son of a physician and went through the usual education of a middle-class family. He passed all examinations in the Gymnasium with honors and matriculated at the



Dr. Artur Schüller

Vienna University Medical School, which at that time had a high rank. He was always at the top of his class and graduated *Sub Auspiciis Imperatoris* (under the auspices of the emperor), a distinction rarely granted, somewhat similar to our *summa cum laude*.

Dr. Schüller settled as a young assistant in neurology at about the time when Guido Holzkecht had just begun working in the medical field with the newly discovered roentgen rays. The earliest period of application of those new rays to diseases of the brain was characterized by wild and unsubstantiated diagnoses of tumors, abscesses, and hemorrhages, at a time when the fundamentals of roentgenologic visualization, the knowledge of the normal conditions, and proper correlation of abnormal findings with gross morphologic pathology were still in the earliest beginning.

Schüller, guided by Holzkecht, understood that structural changes in the soft mass of the brain substance could not be identified; he recognized, however, that the impression of intracranial lesions upon the skeletal skull would provide a solid basis for roentgenologic diagnosis. And with untiring zeal he studied, photographed, and radiographed all available skull preparations in the departments and museums of anatomy, pathology, and forensic medicine. Stimulated by Oppenheim of Berlin, he began early the study of the sella turcica and published the first "Atlas on the Radiology of the Base

of the Skull" in 1905. He was the first to recognize and correctly interpret the calcified pineal gland (1906). His comprehensive monograph on the "Roentgen-diagnosis of the Head" appeared in 1912; in 1915 he described two cases of a particular syndrome of decalcified areas located mainly in the calvaria, "geographical skull," with occasional lesions also in the extremities. These changes were associated with diabetes mellitus. Henry Christian, in Boston, reported a similar instance in 1920 and referred to Schüller's observation. Both authors thought of some sort of dyspituitarism.

We remember Professor Schüller, as we used to call him, giving his courses to small groups in the living room of his house, leaning against the grand piano on top of which he had the viewing box. There he demonstrated sutures and diploic veins, the veins of Breschet, turricephaly and other cranio-stenoses; he taught us how to distinguish sellar changes due to pituitary tumors from those caused by increased intracranial pressure. He told us how Dandy in 1918 observed incidentally air in the brain in a case of rhinomeningeal fistula, which started him on pneumoventriculography.

Schüller published three monographs and more than 100 other papers. He was a member of radiologic societies of Austria, Australia and New Zea-

land, Sweden, Great Britain, the United States, Italy, Romania, Poland, and elsewhere.

When he had to leave Vienna after the occupation of Austria by the Nazis (he lost his two sons then and there), he went to Australia and was hospitably welcomed in Melbourne. He was appointed honorary research officer at the University there, and had an active consultative practice in his office and two hospitals. Dr. Merrill C. Sosman, on his trip around the world, visited Schüller last summer.

Schüller's work, which he pursued with fanatic enthusiasm, filled his life. But, besides, he loved music and was a good violinist. He and his wife used to enjoy playing duosonatas—and chess.

Dr. Frank Morgan of Melbourne, a renowned neurosurgeon, wrote to Dr. Sosman: "Professor Schüller died at St. Vincent Hospital in the arms of his devoted wife, quite suddenly but not unexpectedly. He was buried on the feast of All Souls at St. Johns Church, Heidelberg—in view of the hills there, which so much reminded him of his beloved Vienna. He was the perfect gentleman, the noblest character I ever met. Apart from all this, he was one of the great medical men of his time in Australia. We count ourselves fortunate that he came to live among us." FELIX G. FLEISCHNER, M.D.

It is with deep regret that we report the death, on March 25, of Dr. Clarence E. Hufford of Toledo, Ohio, Past-President of the Radiological Society of North America. Further notice will appear in a forthcoming issue of RADIOLOGY.

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RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Theodore R. Miller, M.D., 139 E. 36th St., New York 16, N. Y.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, C. Allen Good, M.D., Rochester, Minn.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

ASSOCIATION OF UNIVERSITY RADIOLOGISTS. *Secretary-Treasurer*, Paul Riemenschneider, M.D., Department of Radiology, Medical College, State University of New York, Syracuse, N. Y.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, T. Leucutia, M.D., 10 Peterboro, Detroit 1, Mich.

SOCIETY OF NUCLEAR MEDICINE. *Secretary*, Robert W. Lackey, M.D., 452 Metropolitan Bldg., Denver 2, Colo.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Garland Wood, Jr., M.D., Medical College of Alabama, Birmingham 3.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 1313 N. Second St., Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, E. A. Mendelsohn, M.D., Holt-Krock Clinic, Fort Smith. Meets quarterly.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Nathan M. Spishakoff, M.D., 405 N. Bedford Drive, Beverly Hills.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Putnam C. Kennedy, M.D., 540 N. Central Ave., Glendale 3. Meets second Wednesday, September, November, March, April, and June, Los Angeles County Medical Association Building.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY. *Secretary*, LeRoy K. Mills, M.D., 3235 Fair Oaks Blvd., Carmichael. Meets last Monday of every other month, September to May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA. *Secretary-Treasurer*, Harold P. Tompkins, M.D., 658 S. Westlake, Los Angeles 57.

REDWOOD EMPIRE RADIOLOGICAL SOCIETY. *Secretary*, Lee E. Titus, M.D., 164 W. Napa Street, Sonoma, Calif. Meets second Monday every other month.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, Stanley A. Moore, M.D., 2466 First Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irma Smith, M.D., 450 Sutter St., San Francisco 8. Meets quarterly, at Grison's Steak House.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Stanford B. Rossiter, M.D., 1111 University Dr. Menlo Park.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, John H. Heald, M.D., 450 Sutter St., San Francisco 8. Meets third Thursday at 7:30 P.M., Children's Hospital, September through June.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Lorenz R. Wurtzebach, M.D., 601 E. Nineteenth Ave., Denver 5. Meets monthly, third Friday, at Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, Ralph J. Littwin, M.D., Bristol Hospital, Bristol. Meets bimonthly, second Wednesday.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary-Treasurer*, Charles E. Bickham, Jr., M.D., 1835 Eye St., N.W., Washington 6. Meets third Wednesday, January, March, May, and October, 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. Robert DeArmas, M.D., 135 Broadway, Daytona Beach. Meets in April and in October.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George P. Daurelle, M.D., Jackson Memorial Hospital, Miami 36. Meets monthly, third Wednesday, 8:00 P.M., at Jackson Memorial Hospital.

NORTH FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Marvin Harlan Johnston, M.D., Five Points Medical Center, Jacksonville 4. Meets quarterly, March, June, September, and December.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Luther Clements, Jr., M.D., 35 Linden Ave., N.E., Atlanta 8. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Herbert M. Olnick, M.D., 417 Persons Bldg.

Macon, Ga. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary,* Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta. Meets first Thursday of each month.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary-Treasurer,* Jun-chu'an Wang, M.D., The Queen's Hospital, Honolulu 9. Meets third Monday of each month.

Idaho

IDAHO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Charles R. McWilliams, M.D., Twin Falls.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary-Treasurer,* Arthur S. J. Petersen, M.D., 11406 S. Parnell Ave., Chicago 28. Meets at the Sheraton Hotel, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary,* William Meszaros, M.D., 1825 W. Harrison St., Chicago.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer,* Chester A. Stayton, Jr., M.D., 313 Hume-Mansur Bldg., Indianapolis 4. Meets twice a year, first Sunday in May and during fall meeting of State Medical Association.

TRI-STATE RADIOLOGICAL SOCIETY (Southern Indiana, Northwestern Kentucky, Southeastern Illinois). *Secretary-Treasurer,* Robert E. Beck, M.D., 600 Mary St., Evansville, Ind. Meets last Wednesday, October, January, March, and May, 8:00 P.M., at the Elks' Club, Evansville, Ind.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary,* James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary,* James R. Stark, M.D., 3244 East Douglas St., Wichita. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Robert H. Akers, M.D., 1405 West Broadway, Louisville 3. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary,* Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA. *Secretary-Treasurer,* Seymour Ochsner, M.D., Ochsner Clinic, New Orleans 15.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary,* W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Francis J. O'Connor, M.D., Augusta General Hospital, Augusta. Meets in June, October, December, and April.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer,* James K. V. Willson, M.D., 1100 N. Charles St., Baltimore 1. Meets third Tuesday, September to May.

MARYLAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Nathan B. Hyman, M.D., 1805 Eutaw Place, Baltimore 17.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer,* Joseph O. Reed, Jr., M.D., 3825 Brush, Detroit 1. Meets first Thursday, October to May, Wayne County Medical Society rooms.

UPPER PENINSULA RADIOLOGICAL SOCIETY. *Secretary,* Arthur Gonty, M.D., Menominee. Meets quarterly.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* O. J. Baggenstoss, M.D., 1953 Medical Arts Bldg., Minneapolis 2. Meets three times a year.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Robert P. Henderson, M.D., 316 Medical Arts Bldg., Jackson. Meets monthly, on third Tuesday, 6:30 P.M., at Hotel Edwards, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary-Treasurer,* Lewis Allen, M.D., 907 N. 7th St., Kansas City 1, Kans. Meets last Friday of each month.

GREATER ST. LOUIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Charles J. Cherre, M.D., 462 N. Taylor, St. Louis 8. Meets on fourth Wednesday, October to May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Arthur T. Austin, M.D., 104 Doctors Bldg., Billings. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Wayne K. Tice, M.D., 128 N. 13th St., Lincoln 8. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

CONNECTICUT VALLEY RADIOLOGIC SOCIETY. *Secretary-Treasurer*, Paul J. Kingston, M.D., 114 Woodland St., Hartford, Conn. Meets second Friday of October and April.

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, John E. Gary, M.D., 1180 Beacon St., Brookline 46, Mass. Meets monthly on third Friday, October through May, at the Harvard Club, Boston.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnson, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Dr. Andrew P. Dedick, Jr., M.D., 67 E. Front St., Red Bank. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BROOKLYN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Solomon Schwartz, M.D., 555 Prospect Place, Brooklyn 38. Meets first Thursday, October through May.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary*, Charles Bernstein, M.D., 685 Delaware Ave., Buffalo 9. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Joseph A. Head, M.D., University Hospital, 150 Marshall St., Syracuse. Meets first Monday, October through May.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. P. Naidorf, M.D., 411 Parkside Ave., Brooklyn 26. Meets fourth Thursday, October to April (except December), at 9:00 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Jerome Zwanger, M.D., 126 Hicksville Road, Massapequa. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Harold G. Jacobson, M.D., Montefiore Hospital, 210th St. and Bainbridge Ave., New York 67, N. Y.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving Van Woert, Jr., M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.

RADIOLOGICAL SOCIETY OF STATE OF NEW YORK. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets annually with the State Medical Society.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, John W. Colgan, M.D., 277 Alexander St., Rochester 18. Meets at Strong Memorial Hospital, 8:15 P.M., last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arnold Myron Wald, M.D., 406 Boston

Post Road, Port Chester. Meets third Tuesday of January and October and as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, William H. Sprunt, M.D., North Carolina Memorial Hospital, Chapel Hill, N. C. Meets in April and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Marianne Wallis, M.D., Minot. Meets in the Spring with State Medical Association; in Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary*, Francis C. Curtzwiler, M.D., 421 Michigan St., Toledo.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arthur R. Cohen, M.D., 41 S. Grant Ave., Columbus. Meets second Thursday, October, November, January, March, and May, 6:30 P.M., Fort Hayes Hotel, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Frederick A. Rose, M.D., 2065 Adelbert Road, Cleveland 6. Meets at 7:00 P.M., fourth Monday, October, November, January, February, March and April, at Tudor Arms Hotel.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Warner A. Peck, Jr., M.D., 441 Vine St., Cincinnati 2. Meets first Monday, September through May, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, G. F. Johnson, M.D., 1030 Reibold Bldg., Dayton 2, Ohio. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary*, Sol Wilner, M.D., Medical Arts Bldg., Tulsa.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. V. Allen, M.D., 9855 S.W. Hawthorne Lane, Portland. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club, Portland.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert W. Hanf, M.D., 807 South Auburn, Kennewick, Wash. Meets in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary*, Walter P. Bitner, M.D., 234 State St., Harrisburg. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Roderick L. Tondreau, M.D., 3400 Spruce St., Philadelphia 4. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary*, Edward M. Schultz, M.D., 3401 Fifth Ave., Pittsburgh 13.

Meets monthly, second Wednesday, at 6:30 P.M., October to May, at the Hotel Roosevelt.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John H. Freed, M.D., 4200 E. Ninth Ave., Denver 20, Colo.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary*, Wayne Reeser, M.D., 1600 Ninth Ave., Conway. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

The Southeast

Southern Radiological Conference. *Secretary-Treasurer*, Marshall Eskridge, M.D., 1252 Springhill Ave., Mobile, Ala.

The Southwest

SOUTHWESTERN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Gordon L. Black, M.D., 1501 Arizona Bldg., El Paso, Texas.

Tennessee

MEMPHIS ROENTGEN SOCIETY. *Secretary-Treasurer*, James L. Booth, M.D., 899 Madison Ave., Memphis 3. Meets monthly first Monday, John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George K. Henshall, M.D., 311 Medical Arts Bldg., Chattanooga 3. Meets annually with State Medical Association in April.

Texas

DALLAS-FORT WORTH RADIOLOGICAL CLUB. *Secretary*, Albert H. Keene, M.D., 3707 Gaston Ave., Dallas. Meets monthly, third Monday, 6:30 P.M., at the Greater Fort Worth International Airport.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Edward Singleton, M.D., 6621 Fannin St., Houston 25. Meets fourth Monday at the Doctors' Club.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets at Brook Army Medical Center, second Wednesday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Jarrell E. Miller, M.D., 3500 Gaston Ave., Dallas 26. Next meeting in Dallas, Jan. 30-31, 1959.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Kearney, 2nd., M.D., 110 S. Curry St., Phoebus.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Eva L. Gilbertson, M.D., 1317 Marion St., Seattle 4. Meets fourth Monday, September through May, at 610 Pine St., Seattle.

West Virginia

WEST VIRGINIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. Paul Elkin, M.D., 515-519, Medical Arts Bldg., Charleston. Meets with State Medical Society, and as arranged by Program Committee.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Jerome L. Marks, M.D., 161 W. Wisconsin Ave., Milwaukee 1. Meets monthly on fourth Monday at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Fibro-osseous Dysplasia of the Skull. A Case Report. Norman Lenson. *J. Bone & Joint Surg.* 39-A: 651-655, June 1957. (1096 Beacon St., Brookline 46, Mass.)

The author uses the term fibro-osseous dysplasia to designate the condition described in this case report "in order to avoid neoplastic implication and the problems encountered in pathologic classification and pathologic and roentgenographic correlation."

A ten-year-old girl was seen with several bone-hard lesions in the skull and a mass in the neck. At three years of age she had struck the right side of her head against a hard object, resulting in right peri-orbital, frontal and parietal edema with ecchymosis. Three months later the tumors of the skull and the mass in the neck were noted. All increased progressively in size. Eight tumors were palpable on the right side of the skull. These varied from 1.0 cm. to 2.5 cm. in diameter and were located at the supra-orbital ridge, in the right frontal, parietal, and occipital areas. There was thickening of the skull 2.0 cm. in width, extending distally from the right supra-orbital ridge. The mass in the neck measured 7.5×5.0 cm.

Roentgenograms showed several small osteomata, from 1 to 2 cm. in diameter, in the region of the lambda, the posterior sagittal, and the right frontoparietal areas. There were multiple abnormalities of the cervical spine, many of which were developmental. The roentgenographic diagnosis of the cranial lesions was osteoma.

The diagnoses made by different pathologists varied. They were as follows: (1) localized developmental abnormality or intramembranous ossification involving dense fibrous tissue and vascular ectasia; (2) mixed fibrous tissue and bone from skull sutures; (3) osteoma (bone protuberances) from deposition of new bone on the outer table and diploidization of the new bone.

Three roentgenograms; 2 photomicrographs; 2 photographs.

H. C. JONES, M.D.
Grand Rapids, Mich.

Pneumoencephalography in Tuberculous Meningitis.

José E. Sifontes, Sabato V. R. Sordillo, and Edith M. Lincoln. *J. Pediat.* 50: 695-707, June 1957. (E. M. L., 660 Park Ave., New York 21, N. Y.)

In the authors' opinion, pneumoencephalography should be performed in children with tuberculous meningitis when progress is unsatisfactory. The procedure is of great importance in evaluating the underlying pathological process and in the prognosis.

Thirty-eight pneumoencephalographic studies were carried out in 27 children, some of whom had recovered or were recovering from tuberculous meningitis, while others were either early in the course of the disease or in the later phases of treatment. Air replacement, usually by the lumbar route, was performed in the erect position, and roentgenograms were taken at a 6-foot distance, in upright postero-anterior and lateral positions after 20 c.c. of air had been injected. Further replacement was done as necessary, and films taken in the upright anteroposterior, postero-anterior, and right and left lateral projections with the patient horizontal. The diagonal width of the lateral ventricles was used

as the basis for measurement. All living patients were followed three years or more after completion of treatment.

The patients tolerated pneumoencephalography well. The most common reaction was fever of three or four days duration. The only fatality attributable to the procedure in the series occurred in a thirty-three-month-old boy who was mentally retarded and had marked hydrocephalus. He died five days after ventriculography, in the second year after the onset of meningitis.

Ten patients were found to have hydrocephalus of various degrees of severity. Two patients without hydrocephalus had no filling of the ventricles. Fifteen patients had normal ventricles.

The highest mortality was observed in the patients with hydrocephalus. These patients also came to treatment in the more advanced forms of the disease, uniformly failed to show air in the subarachnoid space, and had more frequent neurological sequelae.

The presence of obstruction in the basal cisterns usually indicates a poor prognosis. In a few cases arrest of the hydrocephalus will occur spontaneously. Patients in whom the meningitis is arrested, but in whom the hydrocephalus is progressive, become problems of surgical management.

A normal pneumoencephalogram usually, but not always, indicates a good prognosis.

Ten roentgenograms; 5 tables.

Appearance and Significance of Air Images in the Intracranial Subdural Space Following Cisterno-Encephalographic and Ventriculographic Examinations: Study Based on 1,030 Cases of Cisterno-Encephalography and 100 Cases of Ventriculography. G. C. Canossi, R. Reggiani, and R. Bergonzini. *Radiol. med.*, Milan 43: 20-38, January 1957. (In Italian) (Clinica per le Malattie Nervose e Mentali dell'Università di Bologna, Bologna, Italy)

The authors review the problem of the appearance of air in the subdural space in ventriculography and pneumoencephalography. After presenting a summary of the literature on the subject, they relate their own experiences based on over 1,000 pneumoencephalograms and 100 ventriculograms. They have encountered intracranial subdural air collections in 10.4 per cent of the cases in which pneumoencephalography was performed. They attribute penetration of air into the intracranial subdural space in large part to its direct collection in the spinal subdural space, due in most cases to some error in technic or to movement of the patient, frequently a child. In a small number of cases, especially the ones where the appearance of subdural air is delayed, the possibility of an arachnoidal laceration exists. This is more frequent following craniocerebral trauma and in cases of arachnoiditis.

The sites of collection of intracranial subdural air depend on the position of the patient's head during exposure. The best projections are with the head upright. Difficulties in interpretation occur with retro-sellar collection of air. In these cases the picture resembles cisternal block rather than a subdural air collection. Sometimes abundant collections of subdural air over the hemispheres may resemble atrophy and subarachnoid collection.

In the 100 cases in which ventriculography was performed, subdural air was encountered in 38. Air in these cases can reach the subdural space either through the needle hole in the dura or by reflux from the ventricles, through the needle track. In 84 per cent of cases the air collected over the convexity of the hemispheres. In 60 per cent of cases it was found in the interhemispheric fissure. In 8 per cent it could even be found on the inferior surface of the tentorium. In ventriculography, subdural air usually does not lead to difficulties in interpretation except when, as a result of unequal amounts on the two sides, a lateral deviation is produced.

Twenty-six roentgenograms; 2 diagrams.

ALEXANDER R. MARGULIS, M.D.
University of Minnesota

Complications of Pneumoencephalography Associated with Internal Carotid Thrombosis. Seymour Solomon and Kevin D. Barron. *Neurology* 7: 373-380, June 1957. (Montefiore Hospital, New York 67, N. Y.)

A large majority of the deaths associated with pneumoencephalography have occurred in patients with brain tumor; deaths of patients with cerebral vascular disease have been mentioned but rarely in the literature. The authors review briefly the only 5 cases of occlusion of the internal carotid artery following pneumoencephalography which they were able to find, together with 4 cases with focal cerebral complications.

Two new cases of cerebral infarction following pneumoencephalography are reported. These were observed within a short span of time and suggest that significant morbidity may be greater than has been realized. In both there was evidence of vascular disease. Both patients appeared to tolerate the procedure well, and the new neurologic signs did not appear until many hours after pneumoencephalography; in 1 case hourly blood pressure recordings failed to reveal hypotension. The collateral circulation through the ipsilateral external carotid via the ophthalmic artery was demonstrated in both cases. However, as judged by the relative lack of clinical and electroencephalographic change on attempts to occlude the ipsilateral common carotid, this collateral circulation was not clinically significant. In 1 case a history of neck trauma prior to symptoms of carotid artery occlusion suggests a causal relationship. The fact that the "carotids were bilaterally palpable and equal" in this case again indicates the unreliability of this simple test in determining patency of the internal carotid artery.

The incidence of cerebral infarction following pneumoencephalography is undoubtedly low. This is due in part to the fact that a relatively small percentage of air studies are performed in individuals over fifty years of age. A second factor is that most patients subjected to air studies with symptoms which later prove to have been caused by internal carotid artery thrombosis are individuals in whom the occlusion has resulted in a maximum zone of infarction and consequent severe neurologic deficit. The condition is not made worse, simply because a maximum deficit already exists. In contrast, in the authors' cases, and in those reviewed, only minimal defects were present prior to pneumoencephalography.

The authors believe that a more thorough recognition of the manifestations of internal carotid artery disease will tend to prevent the use of pneumoencephalography under such circumstances. Caution in performing air

studies on patients with any evidence of vascular disease is stressed. Oxygen has been advocated for relief of the discomfort following pneumoencephalography; the authors believe, however, that in individuals in whom cerebrovascular disease is suspected, especially of the internal carotid, the benefits of oxygen inhalation are outweighed by the possible deleterious effects. The substitution of carbon dioxide-oxygen is suggested. Prophylactic anticoagulant therapy in patients with cerebrovascular disease might be considered, but the authors feel that, because of possible hazards of such medication, its use is not warranted.

Two roentgenograms.

Orbitography with Water-Soluble Contrast Media. G. Lombardi. *Acta radiol.* 47: 417-425, June 1957. (Roentgen Department of the Ophthalmic Institute, Milan, Italy)

The author uses a water-soluble contrast medium for orbitography and evaluates his results in 50 cases. Briefly, the technic consists in the injection into the muscular cone of the eye of 3 to 5 c.c. of Umbradil 21 per cent, containing novocaine and hyaluronidase. A pressure dressing is then applied to the eye. Anteroposterior and lateral films are obtained, with additional views as indicated. Absorption of the medium is complete in fifteen minutes. Repeat injections, if necessary, are performed at a later date.

Mild pain and edema are expected complications. Leakage of the medium into the subdural spaces occurred in 2 cases and produced intense pain with nausea and vomiting. No permanent optic damage is recorded in this series.

Detailed descriptions of the normal and pathologic radiographic anatomy and of the distribution of the contrast material in the orbit are given. Of the 50 cases examined, 15 are excluded from consideration because of extravasation of the medium; in 16 cases the findings were negative, and in 19 cases positive. A large number of the failures were first attempts. All 19 patients in whom the examination produced positive results had unilateral exophthalmos. Differential diagnosis of the lesions was not possible.

The author concludes that the indications for orbitography are the presence of a tumor or suspected tumor. The main benefit derived from the procedure is knowledge as to extent of the lesion, aiding in selection of the most suitable operation.

Twenty-five roentgenograms.

NEIL E. CROW, M.D.
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Orbital Pneumography. Torstein I. Bertelsen and Olaf Petersen. *Acta radiol.* 47: 426-432, June 1957. (University Hospital, Copenhagen, Denmark)

The diagnosis of noninflammatory space-filling lesions in the orbit by routine roentgenographic methods and by tomography is fraught with difficulty. The authors emphasize the value of introducing contrast material into Tenon's capsule or into the retrobulbar space as an aid in definitive diagnosis. A negative contrast medium (air or oxygen) is felt to be preferable to either aqueous or oily media because of its nonirritating qualities and its relatively slow absorption.

The technics of injection into Tenon's capsule and into the retrobulbar space are described in detail. The first procedure is recommended when the clinical features indicate a juxtabulbar tumor or perhaps a

tumor originating from the globe proper. A suspected space-filling lesion within the orbit but far from the eye, perhaps in the orbital wall, is best studied with a retro-bulbar injection of air.

Complications are rare as reported in the literature. Air embolism is described in one case, producing left-sided convulsions, basilar constriction in the right half of the face, and unconsciousness. Ophthalmoscopy revealed air in the retinal vessels. All signs subsided within twenty minutes. Subconjunctival hemorrhages and minor hemorrhages in the orbit are thought to be not uncommon but of questionable significance, as they subside spontaneously. The risk of infection appears to be slight.

Contraindications to this examination are: (1) infections in the orbit; (2) suspected injury of the eyeball.

The authors present a series of 8 cases of unilateral exophthalmos in which this examination was of definite diagnostic value.

Six roentgenograms; 2 photographs; 1 anatomical drawing.

BYRON G. BROGDON, M.D.
Parks Air Force Base, Calif.

Studies on the Lateral Neck Radiograph. Doris Bate, Oscar Ruiz, and Arnold L. Bachman. *Brit. J. Radiol.* 30: 298-304, June 1957. (Francis Delafield Hospital, New York, N. Y.)

The appearance of the soft tissues in radiographs of the neck were studied in 100 randomly selected cases in order to establish the normal variations and aid in the recognition of pathological deviations.

The pre-epiglottic space is a fat-filled triangular zone bounded posteriorly by the cartilage of the epiglottis, superiorly by the base of the tongue and valleculae, anteriorly by the hyoid bone and hyothyroid membrane, and inferiorly and laterally by the thyroid cartilage. The space may be invaded by carcinoma of adjacent structures. Tumors of the base of the tongue may extend inferiorly to infiltrate all or parts of the fatty triangle; cancer of the epiglottis may grow downward and forward to involve the space; and tumors of the vocal cords, especially those arising anteriorly, may pass through the anterior commissure and epiglottic cartilage to reach it. In all normal cases the pre-epiglottic space appeared almost homogeneously radiolucent. When the space was infiltrated by carcinoma, the normal fatty tissue was replaced to a varying degree by malignant tissue of greater density. As a result, instead of the normal fatty radiolucency there were irregular shadows of water density.

The epiglottico-ventricular angle is formed by the foot of the epiglottis with the true cord. In all normal patients, unless its visualization was obscured by calcification of the thyroid cartilage or lack of air in the ventricle, this angle was clearly defined. Obliteration of the angle was found to be due to a soft-tissue mass contiguous with the anterior commissure and foot of the epiglottis. Such a mass was either neoplastic (usually) or inflammatory. Tumors arose from the area as the primary site, or extended to it from the epiglottis, ventricle, false cord, true cord, or subglottic region. Regardless of the site of origin, obliteration of the angle indicated involvement of the commissure and of both sides of the larynx.

The submaxillary soft-tissue shadows are rhomboidal in shape. One line of the rhombus is formed by the inferior border of the mandible. The postero-inferior margin is represented by the body of the hyoid bone,

and the posterosuperior border by the base of the tongue. The antero-inferior line is a free border that extends from the symphysis menti to the anterior face of the body of the hyoid bone. The soft-tissue shadow of the submaxillary region is formed by the suprahyoid muscles which extend from the mandible to the hyoid bone. The anterior inferior border of the submaxillary soft tissues was above a line drawn from the symphysis to the inferior angle of the anterior face of the body of the hyoid bone in 84 out of 100 cases. In 96 per cent of the cases, the free border of the submaxillary fat tissue was less than 2 mm. below the mentohyoid line. It appeared that a submaxillary soft-tissue shadow of water density, extending 2 mm. or more below the mentohyoid line, should be considered suggestive of enlarged submaxillary or submental nodes, or any other process displacing the suprahyoid muscle downward.

In normal individuals the two vocal cords are at the same level and the inferior contour of the laryngeal ventricle in the lateral view is therefore seen as a single line. In certain cases with a paralyzed cord, the cords are at different levels and the lower border of the air-filled ventricle on the involved side produces a double contour on the lateral roentgenogram.

In a series of 100 cases of well visualized normal ventricles, only one showed a suggestive dissociation of the cords, representing a false positive.

Thirteen figures, including 5 roentgenograms.

H. L. STEINBACH, M.D.
University of California, S. F.

Carotid Angiography in Diagnosis and Treatment of Tumors of the Neck. Nicholas Wetzel. *Arch. Surg.* 74: 954-956, June 1957. (700 N. Michigan Ave., Chicago 11, Ill.)

Two cases are presented in which carotid angiography was useful in the diagnosis and treatment of pulsating masses in the superior triangle of the neck. In one patient an aneurysm of the internal carotid artery was treated by simple common carotid ligation. In the other a carotid body tumor was removed following ligation of the common carotid, the internal carotid, and the external carotid.

Preoperative information provided by angiography is desirable in assessment of the collateral circulation and the extent of the lesion. This is useful if ligation of the common carotid becomes necessary or as a guide to arterial grafting or anastomosis after resection.

Two roentgenograms. J. E. CARLISLE, M.D.
Shreveport, La.

THE CHEST

Bronchography in the Diagnosis of Pediatric Problems. Charles F. Ferguson and Carlyle G. Flake. *J.A.M.A.* 164: 518-521, June 1, 1957. (C. F. F., 300 Longwood Ave., Boston 15, Mass.)

Early diagnosis of bronchopulmonary abnormalities in children is highly important if they are to benefit maximally from the recent advances in thoracic and cardiovascular surgery. The following findings should give impetus to prompt specialized study: (1) chronic lung changes as seen on routine films; (2) unexplained chronic cough; (3) stridor not proved to be of laryngeal origin; (4) recurrent infection in the same area of the lung; (5) persistent or recurring wheezing arising from the same area of the lung; (6) hemoptysis (not a usual finding in childhood).

There are many causes for *bronchiectasis* including the rare take-off of an aberrant bronchus from the right side of the lower trachea to supply a right upper lobe segment. Bronchography for localization should not be omitted no matter how obvious the cause or whatever the treatment proposed.

Agensis of the lung may be misinterpreted as atelectasis or unresolved pneumonia, but bronchography quickly establishes the diagnosis and determines whether there is a true aplasia, a tracheal bud, or an hypoplastic bronchus with no lung tissue.

In patients with a patent esophagus the demonstration of a *tracheoesophageal* fistula may present difficulties. It should be suspected in infants who have a loose cough and choking after liquid feedings with recurrent pneumonitis of the aspiration type. If the fistula is not demonstrated by the swallowing or instillation of contrast medium into the esophagus, bronchography may be helpful in delineating the tract.

While the larynx is still the site of origin in most cases of infantile *stridor*, vascular malformations, diagnosed more and more often, may be the etiologic agent. Barium swallow and/or tracheography will reveal double aortic arches, right aortic arch with constricting ligamentum arteriosum, anomalous courses of the innominate, subclavian or carotid vessels with resulting pressure on the esophagus and/or trachea.

Seven roentgenograms. SAUL SCHEFF, M.D.
Boston, Mass.

Segmental Localization of Upper Lobe Tuberculosis: The Rarity of Anterior Involvement. Walter Lentino, Harold G. Jacobson, and Maxwell H. Poppel. *Am. J. Roentgenol.* 77: 1042-1047, June 1957. (H. G. J., 210th St. and Bainbridge Ave., New York 67, N. Y.)

Early adult-type pulmonary tuberculosis is almost always limited to the apical and posterior segments of the upper lobes. The roentgen demonstration of a lesion involving only the anterior segment of an upper lobe is generally held to exclude tuberculosis. The authors present a case of isolated tuberculous involvement of the anterior segment of the right upper lobe, but in a series of 100 consecutive cases no other such lesion could be found.

The work of Dock, Brock, Macklin, and Boyden is reviewed and their divergent points of view are combined into the authors' concept of "the upper lung." According to this concept, "the upper lung lies above all other segments of the lung, comprises the apical and posterior segments of the upper lobes and the superior segments of the lower lobe and is a unique anatomico-pathologic unit characterized by poor blood circulation, diminished respiratory ventilation, and a distribution of the bronchi favoring embolization." The anterior segments of the upper lobes lie at a lower level and do not share these characteristics. This serves to explain the extreme rarity of early tuberculosis isolated to the anterior segment of an upper lobe.

It is emphasized that involvement of the anterior segment of the upper lobes by contiguity following disease in the apical and posterior segments is not unusual. It is only when an infiltrate or mass is confined to the anterior segment of an upper lobe in an adult, as in the case reported, that the chance of it being tuberculous is remote.

Two roentgenograms; 9 diagrams; 1 table.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

The Significance of Bronchiectasis Associated with Pulmonary Tuberculosis. John K. Curtis. *Am. J. Med.* 22: 894-903, June 1957. (VA Hospital, Madison, Wis.)

The concepts of the pathogenesis of tuberculous bronchiectasis are discussed.

The findings in 13 patients whose sputum remained positive or who had a relapse bacteriologically following segmental resection are reviewed. The indication for the original surgery in most instances was cavitary disease. All but 1 patient had preoperative chemotherapy for six months or longer; 11 received continuous antimicrobial treatment until the time of surgery. Postoperative chemotherapy was adequate in all except 1 patient, who was given a drug to which his organisms were not sensitive. In about half the series organisms resistant to one or more drugs were found in the sputum or resected lung. Relapse occurred in 6 patients after discharge, and 7 patients were still under observation in the hospital at the time of writing. Four patients had bronchopleural fistulas, 3 recurring disease in the same area, and 5 segmental plane cavities with bronchiectatic communication; in 1 the source of infection was not determined. Planigraphy carried out in 12 patients revealed bronchiectasis in 6. Bronchography in 10 patients showed bronchiectasis in 8. Nine of the 13 patients had further resections. In all cases bronchiectasis was demonstrated by x-ray or pathologically.

The author's data, based on careful x-ray studies and pathologic sections, would seem to indicate that tuberculous bronchiectasis may be the important factor in causing relapse or continuing positive bacteriology.

Segmental resection is now an accepted surgical procedure. The author believes that careful appraisal of the involved lobe by planigrams and bronchograms is indicated prior to segmental resection to avoid complications associated with the type of tuberculous bronchiectasis which approaches dangerously near the intersegmental plane of dissection.

Eight cases illustrating the clinical and pathological features of tuberculous bronchiectasis and the importance of bronchiectasis in collapse therapy and surgical resection are reported briefly.

Nine roentgenograms; 2 photographs; 1 photomicrograph; 1 drawing.

Clinical and Roentgen Study on the Healing of Pulmonary Cavities. E. R. Mordasini. *Schweiz. med. Wchnschr.* 87: 649-657, June 1, 1957. (In German) (Med. Universitätsklinik Bern, Bern, Switzerland)

In spite of great progress in the medical and surgical management of pulmonary tuberculosis, cavity healing has remained the chief therapeutic problem. Authors still cannot agree as to the exact mechanism. Some insist that blocking of the draining bronchi must precede cavity closure, while others believe that drainage through bronchi is necessary for healing. It is the author's impression that a biologic turning point or stabilization, resulting in a stationary condition or regression, is the most important factor in cavity healing. This favorable turning point will occur in connection with tuberculostatic drugs and, less frequently, with collapse therapy or spontaneously.

Up to 1950 the author followed cavity healing with serial roentgenograms in 120 cases. Since that time his study has been extended to many more cases, leading to the conclusion that the open as well as the closed type of cavity healing is possible.

In the rare open type, best known to pathologists, the cavity preserves its shape and diminishes in size only gradually. Its wall becomes thinner until finally it may be recognized on the tomogram only as a faint ring shadow. This type usually responds much better to isoniazid medication than to collapse therapy.

In the closed type the draining bronchi become blocked either by caseous endobronchitis or by mechanical pressure in collapse therapy or thoracoplasty. When the draining bronchi are blocked too soon, retention of material in the cavity may lead to exacerbation, with fever, reactivation, and progression of the disease. In 20 per cent of the cases a fluid level develops, gradually obliterating the lumen of the cavity. Thickening of soft caseous material causes shrinkage of the cavity, and when the air is completely shut off and absorbed, the aerobic acid-fast organism is deprived of oxygen and consequently perishes.

In approximately one-half of the cases persistent fluid levels are observed, with temporary ballooning of the cavity, which suggests incomplete closure of the draining bronchi with a check-valve mechanism. In another 20 per cent a concentric decrease in size of the cavity with preservation of the original form is noted, especially in collapse therapy series.

In the most favorable cases, closure of the cavity and of draining bronchi is delayed until clearing of the cavity and thinning of the cavity wall. In such instances there is fibrous bridging of the last remaining tissue defect and, finally, scarring or annihilation (*Ver-nichtung*) of the cavity (20 per cent).

Numerous serial roentgenograms illustrate the various end-results of cavity closure with residual coin lesions, calcific foci, fibrotic strands, disk atelectasis, and even complete clearing.

Forty roentgenograms; 1 diagram.

ERNEST KRAFT, M.D.
Northport, N. Y.

Non-Tuberculous Cavitary Disease of the Lungs.

Eugene G. Laforet and Mitsuko Tashiro Laforet. *Dis. of Chest* 31: 665-677, June 1957. (E. G. L., Boston University School of Medicine, Boston, Mass.)

In an effort to determine the extent to which cavitation may occur in, or be simulated by, nontuberculous conditions, a survey was made of all such cases studied at the Hermann M. Biggs Memorial Hospital (Ithaca, N. Y.) in a thirteen-year period (1937-50). Of the 145 cases reviewed, 141 were instances of acquired nontuberculous pulmonary disease and in 98 of these (70 per cent) cavitation was noted roentgenologically at some time during the course.

The diseases encountered and the incidence of cavitation were as follows:

	Cases	Cavitation
Suppurative bronchopneumonia	1	0
Chronic lung abscess	77	66
Bronchiectasis	1	1
Fungus infection	6	4
Foreign body	8	4
Neoplasm, primary	26	16
Neoplasm, secondary	13	6
Infarct	2	1
Sarcoid	7	0
	141	98

Not included in the above figures are 3 cases of lung

cyst and one of diaphragmatic hernia, in which cavitation was suggested roentgenographically.

The authors also reviewed the literature and list the following nontuberculous entities which may be associated with definite cavitation both roentgenographically and pathologically:

Pneumonitis	Allergy and collagen diseases
Chronic lung abscess	Pneumoconiosis
Bronchiectasis	Sarcoidosis
Fungus and yeast infection	Syphilis (gumma)
Parasitic disease	Aortic aneurysm
Foreign body	Atelectasis
Neoplasm	X-ray therapy
	Pulmonary infarction

Intrapulmonary conditions which may appear to demonstrate cavitation roentgenographically, but which are not characterized pathologically by necrosis include:

Pulmonary emphysema

Congenital pulmonary cysts and allied cystic lesions, including those seen in xanthomatosis
Pulmonary vascular shadows
Trauma to lung parenchyma

Extrapulmonary entities roentgenologically simulating cavitary lung disease are:

Encapsulated empyema
Loculated pneumothorax
Diaphragmatic hernia
Uremia
Calcification in first costal cartilage
Film artifact

Since the x-ray diagnosis in itself is not conclusive, the authors do not stress the differential x-ray characteristics.

Seven roentgenograms; 2 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Calcified Intrathoracic Lesions Caused by Histoplasmosis and Tuberculosis. B. Serviansky and J. Schwarz. *Am. J. Roentgenol.* 77: 1034-1041, June 1957. (B. S., Instituto Nacional de Cardiologia, Mexico, D. F., Mexico)

The authors present evidence that histoplasmosis is the usual cause of pulmonary calcification in the area where that disease is endemic and indicate certain characteristics of the calcifications which may be helpful in differentiating those caused by histoplasmosis from those of tuberculous etiology.

Groups of patients from Cincinnati and New York City were chosen for a comparison between an area having a high incidence of positive histoplasmin and low incidence of positive tuberculin skin tests (Cincinnati) with an area in which the reverse is true (New York). As a result of these as well as of previous studies, it is concluded that there is no doubt of a cause-and-effect relationship between *Histoplasma capsulatum* and pulmonary calcifications in the endemic area.

The authors believe that in most instances calcified histoplasmic intrathoracic lesions can be differentiated from those caused by tuberculosis on the basis of the following criteria:

1. *Size:* A very large percentage of the pulmonary and/or mediastinal calcific lesions in the Cincinnati

group measured 6 mm. or more in diameter. Correspondingly, more than half of patients from the non-endemic area showed calcifications of 5 mm. or less in diameter, and none in this group showed calcified paratracheal lymph nodes.

2. *Appearance of calcification:* "Stippled" calcifications were much more common in the endemic area of histoplasmosis.

3. *Splenic calcifications:* The presence of multiple or laminated splenic calcifications in patients with intrathoracic calcification can be decisive in assigning histoplasmosis as the cause of intrathoracic calcifications.

Eight roentgenograms; 2 photographs; 2 tables.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Calcification in Solitary Nodules of Lung. Matthew E. O'Keefe, Jr., C. Allen Good, and John R. McDonald. *Am. J. Roentgenol.* **77:** 1023-1033, June 1957. (Mayo Clinic, Rochester, Minn.)

The authors made a study of 207 cases of solitary nodules in the lung, for which operative specimens and preoperative roentgenograms were available. Roentgenographic examination of the specimens showed calcification in 39.6 per cent of the benign nodules and 13.9 per cent of the malignant lesions. Preoperative roentgenograms had revealed calcification in 34 per cent of the benign and 3.9 per cent of the malignant group. Obviously, the usual preoperative roentgenograms are not completely efficient in detecting calcification.

The benign granuloma characteristically contains laminated calcifications. Punctate and central calcifications are present less frequently in benign lesions. Calcifications in the hamartoma are usually punctate but may also be of the popcorn type. In malignant nodules calcification is exclusively central or punctate. Only laminated or popcorn calcifications appear to be characteristically benign.

The presence of calcification in a granuloma, unless of the laminated type, does not mean that the lesion is inactive bacteriologically. Study of a small series of cases suggested that laminagraphic studies are more efficient in demonstrating calcifications than are the routine chest projections.

Nine roentgenograms; 5 photomicrographs; 2 tables.

RICHARD F. McCLURE, M.D.
Redondo Beach, Calif.

Unusual Pulmonary Changes Secondary to Chest Trauma. Roy Greening, Adele Kynette, and Philip J. Hodes. *Am. J. Roentgenol.* **77:** 1059-1065, June 1957. (R. G., 3400 Spruce St., Philadelphia 4, Penna.)

A group of six cases is reported, in all of which rather severe nonpenetrating chest wall injuries were sustained, with resultant areas of pulmonary consolidation. The unusual feature in each instance was the development of air-filled cavities within the pulmonary consolidations. The cavities varied in size, were both unilocular and multilocular, and were centrally and peripherally placed, resembling the type of "pneumatocoele" formation seen following the clearing of pneumonia. The time of appearance may be immediate, within a few hours, or after several days.

The authors stress that it is important to recognize that such air-filled cystic spaces can form and that they are not tuberculous in nature, do not represent lung abscesses, and that they will completely clear within a

relatively short period of time, with no sequelae and with little treatment.

Eleven roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Congenital Lobar Emphysema. D. G. Cottom and N. A. Myers. *Brit. M. J.* **1:** 1394-1396, June 15, 1957. (The Hospital for Sick Children, Great Ormond St., London, England)

The authors report 6 cases of congenital lobar emphysema. One was associated with patent ductus, a second with patent ductus plus a ventricular septal defect, a third with a ventricular septal defect, and a fourth with a ventricular septal defect plus pulmonary stenosis. In 3 of these 4 cases there were other congenital anomalies. All 6 infants exhibited dyspnea. In 2 cases cardiac surgery failed to correct the dyspnea and pulmonary surgery followed. Five cases involved the left upper lobe, 1 the right upper lobe.

The diagnosis of congenital lobar emphysema is made roentgenographically. The roentgenogram shows a radiolucent area of the lung with downward displacement of the diaphragm on the same side and possibly herniation of the overdistended lung across the midline. To be differentiated are congenital heart disease, pneumonia, bronchospasm, atelectasis, spontaneous pneumothorax, and large congenital diaphragmatic hernias. The treatment is surgical removal of the affected portion of the lung.

The cause of the emphysema appears to be some form of valvular obstruction which allows the entry of air on inspiration, but does not permit its escape. Two developmental abnormalities which can lead to this condition are flaccid bronchi due to defective cartilaginous rings and redundant flaps of bronchial mucosa which block the return of inspired air.

Six roentgenograms; 1 photomicrograph; 1 table.

PAUL MASSIK, M.D.
Quincy, Mass.

Bronchopulmonary Sequestration: Some Clinical Aspects with Report of Six Cases. Charles T. Pinney and John M. Salyer. *J. Thoracic Surg.* **33:** 791-802, June 1957. (C. T. P., Olean Medical Group, 201 South Union St., Olean, N. Y.)

Six cases of intralobar sequestration are presented. Five of the 6 patients were asymptomatic and the condition was discovered on routine roentgenograms. The diagnosis was established by aortography in 1 case, but this procedure is not recommended unless an arteriovenous fistula is seriously considered as a diagnostic possibility. Laminagraphy was particularly useful. The gross pathology was similar in all cases, conforming to the pattern originally described by Pryce (*J. Path. & Bact.* **58:** 457, 1946). Anomalous aberrant arteries were pulmonary in type. Intimal sclerosis was noted in one of the anomalous vessels. No bronchial communication was demonstrated.

Ten roentgenograms. J. E. CARLISLE, M.D.
Shreveport, La.

The Familial Occurrence of Pulmonary Alveolar Microlithiasis. Merrill C. Sosman, Gerald D. Dodd, W. Duane Jones, and George U. Pillmore. *Am. J. Roentgenol.* **77:** 947-1012, June 1957. (M. C. S., 721 Huntington Ave., Boston 15, Mass.)

This report is concerned with 46 cases of pulmonary

alveolar microlithiasis, including 21 cases previously appearing in the literature and 23 unpublished cases which have come to the authors' attention. Two other cases are mentioned but are not included.

Pulmonary alveolar microlithiasis is a rare condition which is found most often between thirty-one and fifty years of age. Its occurrence appears to be uninfluenced by previous occupations, antecedent disease, racial background or sex. A tendency to familial occurrence may indicate some inherited abnormality or defect in pulmonary metabolism as an etiologic factor.

Clinically, microlithiasis reveals its presence through a slowly increasing pulmonary insufficiency with associated cyanosis, clubbing of the digits, polycythemia, and finally death from anoxemia or right heart failure. There is an initial dormant period which may last from ten to twenty-five years, during which the patient is asymptomatic, and physical findings are normal. The pulmonary changes are most often discovered in the course of routine chest radiography.

When carefully evaluated, the roentgen findings are highly specific. The typical appearance is a fine sand-like mottling of both lungs, uniformly distributed from apices to bases, but much denser at the bases because of the greater thickness of the tissue in these portions. The density is often so great that the margins of the heart and the diaphragm are obscured. Heavily overexposed radiographs may be required to demonstrate the calcific nature of the densities. Each one represents a concretion, similar in appearance to the corpora amylacea of the prostate gland, usually less than a millimeter in diameter, and consisting chiefly of calcium phosphate and calcium carbonate. The calcium deposit is not in tissue but is in the exudate or transudate of an otherwise normal pulmonary alveolus. It is granular, sharp in outline, and irregular in shape. Subpleural deposits may outline the entire pleural surface of the lungs. The intervening tissue spaces are normal until late in the disease. The condition could be due to an abnormality of carbonic anhydrase, which plays an important role in the exchange of oxygen and carbon dioxide and also in maintaining normal balances between the extremes of acidity and alkalinity.

The differential diagnosis includes all miliary disease of the lungs, but the critical point in differentiation from other diseases, which cannot be overemphasized, is the existence of fine discrete shadows of calcific density uniformly distributed throughout both lungs, without evidence of conglomeration or coalescence. If these findings are present, it is highly probable that the patient has pulmonary alveolar microlithiasis.

Thirty-one roentgenograms; 7 photomicrographs; 5 tables.

RICHARD F. McCLURE, M.D.
Redondo Beach, Calif.

Tuberculomas and Hamartomas of the Lung. Comparative Study of 66 Proved Cases. John M. Bleyer and Joseph H. Marks. *Am. J. Roentgenol.* 77: 1013-1022, June 1957. (J. H. M., 185 Pilgrim Road, Boston 15, Mass.)

The roentgen characteristics of 52 pulmonary tuberculomas taken from 41 patients and of 25 pulmonary hamartomas were studied in conjunction with the gross and microscopic pathology of each lesion. A tuberculoma is defined as a tumor-like granuloma caused by the tubercle bacillus, encapsulated by connective tissue, showing no evidence of surrounding inflammation and arising either from a primary or reinfection focus by a

process of encapsulation or from a completely blocked cavity. The hamartoma is a tumor-like formation in which there is an abnormal arrangement of the normal components of the organ from which it arises.

The tuberculoma represents the most benign form of tuberculosis and, in its early stages, is rarely accompanied by advanced tuberculosis. Its benign nature persists only until the capsule breaks down or the antecedent cavity reopens.

All the tuberculomas in this series were well circumscribed and subpleural in location. The shape as observed in the postero-anterior projection was round or oval. There were no perifocal reactions, but in 9 cases the drainage channels to the hilus were accentuated. Translucent areas within the tuberculoma were seen in 14 patients. Calcification occurred in 11 cases, chiefly in the form of small flecks without definite pattern. In over half the cases the tuberculoma was clinically silent and was discovered on routine survey films.

Pulmonary hamartomas are benign lesions which show no lymph node metastases, no multiplicity and no recurrence. Calcification is relatively common. The prominent strands of density which connect a tuberculoma with the homolateral hilus are not seen in association with an hamartoma. Radiolucencies are only occasionally observed. Satellite nodules, such as are occasionally seen with tuberculomas, have not been found.

Fifteen roentgenograms; 3 tables.

RICHARD F. McCLURE, M.D.
Redondo Beach, Calif.

Bronchial Carcinoma Masquerading as a Thin-Walled Cyst. J. Winthrop Peabody, Jr., Edward J. Rupnik, and Joseph M. Hanner. *Am. J. Roentgenol.* 77: 1051-1054, June 1957. (J. W. P., Jr., 1150 Connecticut Ave., N. W., Washington 6, D. C.)

A case is reported in which roentgenograms revealed a thin-walled cyst in the superior segment of the lower lobe of the right lung. A comparison with films taken three months and fourteen months previously showed progressive increase in size of the cavitating lesion and in thinning of its wall. At operation the cyst appeared grossly benign but microscopic sections through the wall led to a diagnosis of epidermoid carcinoma, Grade III, with necrosis.

It is pointed out that cavitation within bronchial carcinomas is not uncommon, but usually the walls are rather thick and nodular. The thinner and less nodular the wall of the cavity, the greater will be the diagnostic difficulty. Attention is called to the hazard in dismissing every cystic pulmonary lesion as benign.

Four roentgenograms. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Bronchial Carcinoma Arising in a Lung Cyst. J. Winthrop Peabody, Jr., Sol Katz, and Edgar W. Davis. *Am. J. Roentgenol.* 77: 1048-1050, June 1957. (J. W. P., Jr., 1150 Connecticut Ave., N. W., Washington 6, D. C.)

Malignant transformation within a lung cyst is regarded by many as a highly remote possibility. However, in one reported series of 40 carefully followed cases of congenital pulmonary cysts, carcinoma developed in 10 (Larkin and Phillips: *Dis. of Chest* 27: 453, 1955). The possibility of malignant degeneration has been held to constitute an indication for removal of such cysts, if feasible.

The authors report a case in which serial roentgenograms depict the evolution of a bronchial carcinoma in the wall of a lung cyst. Serial chest films over a thirty-three-month period were available for study and show a progressive increase in size of a nodule which at first was at the inferior margin of the cyst and measured less than 1 cm. in diameter. Ultimately, this mass attained a diameter of 5.5 cm.

Pathologic examination after pneumonectomy showed undifferentiated bronchial carcinoma associated with a long standing cyst of the lung.

Four roentgenograms. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Ciuffini-Pancoast Syndrome Caused by Extrapleural Apical Echinococcal Cyst. Sergio Massenti and Vincenzo Racugno. *Radiol. med.*, Milan 43: 63-73, January 1957. (In Italian) (Istituto di Radiologia Medica dell'Università di Cagliari, Cagliari, Italy)

The authors report a lesion in the left superior sulcus occurring in a 15-year-old boy. The patient complained of pain in the left scapular region, increasing in intensity and spreading into the axilla, arm and hand. Paresthesia involving at first the fourth and fifth digits and later the entire hand was followed by weakness of the extremity, palpebral ptosis, and miosis of the left eye. Films showed the left pulmonary apex completely occupied by a homogeneous density with a clear-cut rounded inferior border. The ribs were not involved. The vertebrae appeared normal on planigraphy. At operation an echinococcus cyst was found to be present, extrapleural in location and completely filling the left upper thorax.

The authors stress the importance of realizing that nonmalignant lesions can produce the Pancoast syndrome. This they believe is the first case of extrapleural echinococcus cyst arising in this location and presenting this syndrome.

Five roentgenograms.

ALEXANDER R. MARGULIS, M.D.
University of Minnesota

THE HEART AND BLOOD VESSELS

The Prognosis of Atrial Septal Defect. Maurice Campbell, Catherine Neill, and S. Suzman. *Brit. M. J.* 1: 1375-1383, June 15, 1957. (Cardiac Department, Guy's Hospital, London, England)

The authors analyze 100 cases of atrial septal defect studied at the Cardiac Department of Guy's Hospital and the Institute of Cardiology in London. In two-thirds of the series the diagnosis was proved by catheterization or necropsy. In general these patients have a characteristic body build, being tall and slim. True arachnodactyly is rare, but pigeon chest with prominence of the left side is common. There are few symptoms but the physical findings are conspicuous. Forceful precordial pulsations occur, with a tapping apex beat, right ventricular thrust, and a large pulmonary artery. The radial pulse is small. The first heart sound may be abrupt, while the second is only slightly accentuated or even split. There is usually a blowing, soft systolic murmur heard in the left second and third interspaces, often transmitted to the back. This murmur is usually not heard at birth but develops after several months. In 50 per cent of the cases the diastolic murmur is heard at the apex. The murmurs vary

with the size of the shunt and change with progression of the disease. The roentgenogram shows an enlarged right heart, prominent pulmonary arteries, and hilar dance. The aorta is not enlarged. The left auricle and ventricle are normal in size. The x-ray findings are apt to be suggestive but not pathognomonic.

The heart is large from birth on. It generally remains approximately the same for the first twenty-five to thirty-five years but then increases with accompanying symptomatology. The cardiothoracic ratio is usually less than 55 per cent before the age of fifty and greater than 60 per cent after that age. The electrocardiographic changes are variable and in children are not very pronounced. Most characteristic is an abnormal rSR'. The differential diagnosis includes pulmonary stenosis, which exhibits a rasping, systolic murmur with a thrill; ventricular septal defect in which there is a louder, lower, harsher murmur, with a thrill; and anomalous pulmonary venous drainage.

In this series of cases there was a 2.5:1 ratio of females to males, which was disproportionately weighted in favor of females in the older age groups. If the infant lives for the first few months, the prognosis is good, although there is a predisposition to upper respiratory infection, and weight gain is slow. In the first decade the prognosis is good, as it is also in the second decade, and the children lead normal, quiet lives without symptomatology. They are usually seen by a physician because a murmur is discovered on routine physical examination. In the third decade one-third of the patients become worse and complications, such as auricular fibrillation, pulmonary regurgitation, and reversal of the shunt, occur. In the fourth decade more than 50 per cent of the patients have trouble; there were 6 deaths among 20 cases in the authors' series of patients. In the fifth and sixth decades most of the patients have symptoms; there were 4 deaths in this decade.

The mode of cardiac deterioration in 31 cases was right-sided heart failure (13 cases); pulmonary hypertension with central cyanosis and reversal of shunt (11 cases); increased pulmonary pressure with severe symptoms but no failure (5 cases); left-sided heart failure (1 case). The average age at death is thirty-nine years.

Seven cases of auricular septal defect with associated anomalous pulmonary venous drainage were seen. In these cases there are a fixed left-to-right shunt and an unusually high oxygen saturation in the right atrium; selective angiocardiology is often required for diagnosis. There were 12 cases of associated auricular septal defect and pulmonary stenosis. These patients have few symptoms because one lesion tends to compensate for the other, but there are varying degrees to which either lesion may predominate. The patients are generally underdeveloped, have frequent respiratory infections, and a characteristic murmur.

Cardiac catheterization was done on 46 of the cases reviewed. The patients were subdivided into three groups. Group A: 29 patients with left-to-right shunt and large pulmonary flow without increased pulmonary artery pressure. Group B: 8 patients with left-to-right shunt with high pulmonary arterial pressure; no cyanosis. Group C: 9 cases with decreasing left-to-right shunt and increasing right-to-left shunt; cyanosis generally present.

Fifteen roentgenograms; 3 graphs; 3 tables.

PAUL MASSIK, M.D.
Quincy, Mass.

The Problem of Recognition of Myocardial Infarction. V. V. Zodieva and V. F. Belyaeva. *Vestnik rentgenol. i radiol.* 31: 11-17, July-August 1956. (In Russian) (Radiodiagnostic Department of the Roentgen and Radiological Institute, Moscow, Russia) From *Abst. of Soviet Med.* 1: 137, 1957.

150 cases of myocardial infarction were investigated by means of roentgen kymography. In 109 cases the results of electrocardiography and roentgen kymography were in agreement. By means of roentgen kymography infarctions of the anterolateral wall of the left ventricle are detected more often and are easier to find than those of the posterior wall. The appearance of the infarction depends on its extent, depth, and stage of repair. In the stage of cicatrization, crenate deformities of various heights are frequent. In the stage of consolidation of the scar tissue, when the whole thickness of the myocardial wall has lost its function, paradoxical movements of the segments involved appear (outward protrusion in systole and invagination in diastole), pointing to the development of an aneurysm. On the basis of many years of observation, it is stated that normal function is never completely restored in the area of the infarction. The best diagnostic method in myocardial infarction is correlation of the results of electrocardiography and roentgen kymography.

Eight figures; 3 tables. NEVSKAYA, MOSCOW

Radiological Diagnosis of Atherosclerosis of the Abdominal Aorta and Its Branches. Z. G. Spectrova. *Ter. arkh.* 28 (no. 2): 52-58, 1956. (In Russian) (Therapeutic Institute, Academy of Medical Sciences of the USSR, Moscow, Russia) From *Abst. of Soviet Med.* 1: 137, 1957.

The frequency of association of definite atherosclerosis of the abdominal aorta with hypertensive disease is stressed. In addition to the usual roentgenographic examination of the cardiovascular system, films of the abdominal aorta and its pelvic branches were obtained. Two hundred and twenty cases of hypertensive disease were thus investigated. Isolated plaques of calcification were found in the aortic arch in 3 cases only. Calcifications in the abdominal aorta were found in 74 cases, or 34 per cent of the series (40 per cent of all males and 23 per cent of all females). The maximal incidence of diffuse atherosclerosis occurred in those suffering with 3d degree hypertension (49 per cent). Many patterns of calcification were found in the abdominal aorta and its branches.

It is considered that radiological examination of the abdominal aorta and its branches is necessary in the assessment of general atherosclerotic changes and allows appreciation of the frequency of its association with other conditions, especially hypertensive disease. The usual investigation, limited to the thoracic aorta, gives a superficial and distorted view of the whole process. In pronounced atherosclerosis of the abdominal aorta there may be an accumulation of plaques at the level of the origin of the renal arteries. In those cases the hypertension is to be considered symptomatic. Disorders of abdominal organs and disturbances of the circulation of the lower limbs in cases of hypertension may often be associated with atherosclerosis of the abdominal aorta.

Six figures; 1 table. NEVSKAYA, MOSCOW

Unilateral Positive Pressure Breathing as a Means of Partial Shift of the Pulmonary Blood Flow. R. Rimini, J. L. Duomarco, R. Burgos, J. C. Dighiero, J.

P. Saprizo, and G. H. Surraco. *Dis. of Chest* 31: 643-654, June 1957. (Servicio de Asistencia y Preservación Antituberculosa del Ministerio de Salud Pública, Montevideo, Uruguay)

The authors describe a method which permits shunting of blood from a lobe or lung toward the remaining lung parenchyma in order to determine the potential functional value of the latter. The technic is based on the fact that an increase in intra-alveolar pressure in a lobe or lung results in compression of vessels, increases local resistance to circulation, decreases blood flow, and diminishes oxygen uptake. These same findings are present when there is a stabilized pathological process in the lung. Because of excisional pulmonary surgery, it becomes necessary to determine the functional capacity of the healthy lung before surgery.

The shunting of blood is accomplished by blocking the bronchus to the lobe or lung under study and increasing the intra-alveolar pressure to 20 to 25 cm. of water. A simultaneous angiopneumographic examination is made. Tests were conducted on 10 persons, 4 normal, 2 with slight residual fibrous lesions in the lungs, and 4 with tuberculosis.

A Foley type urethral catheter is used to block the bronchus. With the tip of the catheter in place, under fluoroscopic control, the cuff is inflated until the block is accomplished. Film studies reveal a shift of the mediastinum, increased aeration, decreased vascularity, and depression of the diaphragm on the same side; asymmetrical filling of the pulmonary arteries, with less contrast substance, on the blocked side.

In addition to the above, the authors made standard bronchspirometric studies in 40 subjects (6 normal and 34 tuberculous) in the sitting position. They then studied the changes in the spirometric tracings of a lung breathing oxygen at atmospheric pressure, while the other lung was ventilated with either nitrogen at atmospheric or increased pressure, or with oxygen at increased pressure. Bronchspirometric determinations before and after bronchial block also reveal the functional capacity of the healthy lung. In most instances, the healthy lung, during block, shows an oxygen uptake equal to that of both lungs before the bronchial block. This indicates that there is an important deviation of blood to the normal lung.

Nineteen figures, including 14 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Arteriovenous Fistula of the Right Internal Mammary Vessels Following Radical Mastectomy: Visualization by Angiocardiology. Frank Glenn and Israel Steinberg. *J. Thoracic Surg.* 33: 719-722, June 1957. (F. G., 525 East 68th St., New York 21, N. Y.)

A case of arteriovenous fistula of the right internal mammary vessels is presented. The fistula was discovered two years after radical mastectomy. Symptoms were vibrations over the right anterior chest, tenderness, and a whistling noise over the right neck. After the characteristic bruit appeared, the diagnosis was made. Angiocardiology clearly revealed the lesion. Surgical removal was curative.

So far as the authors could determine, an arteriovenous fistula of the internal mammary vessels following surgery has not previously been reported.

One roentgenogram; 1 diagram.

J. E. CARLISLE, M.D.
Shreveport, La.

Studies in Angiocardiology. The Problems Involved in the Rapid, Selective, and Safe Injections of Radiopaque Materials. Development of a Special Catheter for Selective Angiocardiology. Antonio Rodríguez-Alvarez and Gloria Martínez de Rodríguez. *Am. Heart J.* 53: 841-853, June 1957. (John Peter Smith Hospital, Fort Worth, Texas)

The authors review briefly the problems which have arisen in selective angiocardiology and some of the methods employed in their solution. They deal particularly with direct injection of a contrast medium into the heart. A catheter for this purpose must be radiopaque, with a wide inside diameter and smooth walls; it must be easily manipulated and strong enough to withstand the high pressures used, especially at the proximal end. Most important of all, the undesirable feature of recoil, which is commonly noted with the injection of material by catheter, must be overcome.

This last problem the authors have met by the use of six lateral openings at the tip, in opposing pairs. By this means, the recoiling force for a flow of 35 ml. per second is reduced to 3,200 dynes as compared to 78,000 dynes with a single terminal hole. The lineal velocity of the jets and the stimulating effect of their impact on the heart wall opposite the opening had also to be taken into consideration. To solve this problem the average linear velocity of the medium is reduced.

Comment is made on the various opaque media, notably Renografin, and the desirability of a decreased amount of contrast material is considered.

It is stressed that the catheter described is to be used only for the specific purpose for which it was designed, *i.e.*, injection into the cardiac chambers and great vessels or into vessels of a much greater caliber than the catheter itself.

Eight figures. RICHARD H. HAMILTON, M.D.
New York, N. Y.

Role and Interpretation of Arteriograms in Atherosclerosis and Atherosclerotic Aneurysms. Ben Eisenman and Hubert U. Waggner. *Arch. Surg.* 74: 934-943, June 1957. (VA Hospital, 1055 Clermont St., Denver 20, Colo.)

Arteriography is not an entirely harmless procedure, and its hazards must therefore be weighed against its advantages.

The diagnosis of most abdominal and peripheral arterial aneurysms can be made without radiologic visualization. Such studies are indicated only for more accurate localization of their proximal and distal extent and to determine the diameter of the lesion, facts which on occasion alter the surgical approach. Complete reliance is not to be placed, however, on the angiographic delineation of the contours of the aneurysm, since it may appear much smaller than is actually the case.

The diagnosis of occlusive disease is also frequently possible from the history and physical findings, without arteriography. The procedure is indicated in patients who, after thorough clinical study, are considered reasonable candidates for direct arterial surgery. Such studies may furnish accurate data as to the level of the occlusion, the length of the occlusive process, its degree of encroachment on the arterial lumen, and the degree and location of collateral circulation, and may afford an indication of the condition of the vessel on either side of the occlusion.

The discrepancy between angiograms and the opera-

tive appearance of an atherosclerotic lesion emphasizes that marked pathologic changes occur prior to their angiographic appearance and that both the length of the obliterative lesion and the degree of luminal involvement characteristically are underestimated by such studies.

Angiographic and operative changes similar to those found in atherosclerosis were found in the major vessels of the lower extremities in 4 of 8 patients with microscopically proved Buerger's disease. The implications of these findings for the differentiation of these two angiopathies are discussed.

Seven roentgenograms; 3 photographs.

J. E. CARLISLE, M.D.
Shreveport, La.

Arterial "Spasm" in Peripheral Arteriography Using the Catheter Method. Ingmar Wickbom and Osborne Bartley. *Acta radiol.* 47: 433-448, June 1957. (Sahlgrenska Sjukhuset, Gothenburg, Sweden)

The authors reviewed 108 angiographic studies of the extremities performed with a catheter in 1955 and 1956. Local contractions of the vessels, referred to in this paper as "spasm," occurred in 39 per cent of these. The frequency of spasm was, on the average, inversely proportional to the age of the patient and to the width of the vessels examined. Spasm was more common in females than in males. A specific tendency toward its development was apparent in patients with clinical evidence of Raynaud's disease.

As a consequence of the spasm, and due to the result of incomplete filling, visualization of the peripheral vascular regions may be impossible. The changes arising are variable and sometimes difficult to differentiate as to organic or functional origin. Vascular contractions due to spasm may be reduced or reversed by the administration of vasodilating agent. Even in the absence of direct evidence of spasm, filling of the peripheral branches was felt to be more complete after injection of a vasodilator (Priscol).

No complications of significance from spasm were observed in the extremities examined. However, the authors feel that, in examination of organs which are sensitive to ischemic conditions of short duration, spasm of this type may lead to serious complications. In 2 of 20 cases in which the catheter method was used in examination of the carotid artery, complications were encountered, and at least one of these complications was thought to be due to spasm.

In the series reported, the extent to which the type, amount, and concentration of the contrast medium influenced spasm could not be accurately evaluated.

Eighteen roentgenograms; 1 diagram; 2 tables.

BYRON G. BROGDON, M.D.
Parks Air Force Base, Calif.

Arterial Spasm Caused by Puncture and Catheterization. An Arteriographic Study of Patients Not Suffering from Arterial Disease. Åke Lindbom. *Acta radiol.* 47: 449-460, June 1957. (Karolinska Sjukhuset, Stockholm, Sweden)

A series of peripheral arteriographic studies utilizing the puncture and catheterization technic in patients not suffering from arterial disease is reported. From this series, certain conclusions are drawn relating to the appearance of a sustained contraction of smooth muscle in these vessels, producing a diminution in cali-

ber of the artery, so-called "spasm." The studies showed that in medium-sized arteries spasm is provoked by the presence of an object, e.g., a catheter or a metal or nylon guide, in the lumen. Contractions may also be caused by a sharp rise in vascular pressure. Such a spasm ordinarily decreases spontaneously within a period of hours. Although all of the observations were on arteries of extremities, it is felt that behavior in arteries of the same caliber elsewhere would be similar. Such a contraction of the arterial wall may initially be mistaken for irregular intimal thickening caused by arteriosclerosis. One should be cautious in evaluation of narrowing of the arterial lumen in those cases in which a catheter or other object has recently been present in the lumen, or in which the vessel has been dilated by a forceful injection.

Extreme contraction can probably not be produced in large elastic arteries in adults, and marked spasm can be elicited only in the more peripheral, predominantly muscular arteries. Consequently, puncture of arteries should be performed not too far from the heart, where the arterial wall is mainly elastic. In muscular arteries, puncture may be difficult due to spasm. It has been shown that fibrosis of the medial layer of the arterial wall is generally present in arteriosclerosis; it has also been observed that such fibrosis is very common even without marked arteriosclerotic changes in middle-aged and elderly patients. Arteries so affected can not contract and thus arterial spasm is rarely seen in these age groups, which account for the bulk of arteriographic material. Arterial spasm occurs more frequently in females than in males, a tendency which may be related to the predominance of findings associated with the clinical diagnosis of Raynaud's disease in the female.

The final differentiation of arteriosclerotic change and spasm would depend on whether these irregularities of the lumen diminish or disappear after a period of time.

The authors feel that catheters should not be introduced into muscular arteries leading to organs in which a temporary ischemia may cause damage, particularly the brain and heart. They believe that intra-arterial catheterization may be performed in the extremities without risk of producing damage.

Twenty roentgenograms. NEIL E. CROW, M.D.
Parks Air Force Base, Calif.

THE DIGESTIVE SYSTEM

The Falciform Deviation of the Lower Third of the Esophagus. Franco Fossati and Leonardo Papagni. *Radiol. med.*, Milan 43: 113-122, February 1957. (In Italian) (Istituto di Clinica Medica Generale dell'Università di Milano, Milan, Italy)

The falciform deviation of the esophagus has received little recognition in the literature. It is produced by displacement as the esophagus crosses a tortuous, arteriosclerotic elongated descending aorta. This deviation is rather sharp, it is to the left and anterior and occurs in the vicinity of, and above, the diaphragm. Barium will often stop temporarily at the point of deviation. The authors report their experiences with 4 cases, with dysphagia in 1.

A deviation of the esophagus to the right occurs rarely. It is possible, however, for the esophagus in the same case to slide with deglutition or change in position from left to right.

The differential diagnosis lies between the condition described and displacements by aneurysms and mediastinal and paravertebral masses. The distinction usually presents no difficulties. The esophagus in this type of displacement preserves its motility and elasticity, the deviation is regular, and the aorta can be demonstrated. If necessary, planigraphy (preferably associated with pneumomediastinum), angiocardigraphy, and aortography will clearly demonstrate the cause of the displacement.

Eleven roentgenograms; 3 diagrams.

ALEXANDER R. MARGULIS, M.D.
University of Minnesota

Duodenal Compression by the Mesenteric Artery. Margaret Prouty and William L. Waskow. *J. Pediat.* 50: 734-737, June 1957. (Jackson Clinic, Madison, Wisc.)

Compression of the duodenum by the superior mesenteric artery must be considered in a patient with the triad of belching, bloating, and borborygmus, especially if accompanied by midepigastria discomfort, vomiting, and constipation, and if symptoms are chronic and recurring. Two cases are reported. One patient was a premature newborn infant, with total obstruction, and the other, a fourteen-year-old girl, whose distress had been present from birth.

Upper gastrointestinal fluoroscopic and film studies are necessary to make the diagnosis. Unfortunately, the roentgenologist and the clinician are too often unmindful of the possibility of duodenal compression by the mesenteric artery, and reverse peristalsis in the duodenum is ignored. Surgically a slightly dilated duodenum, especially if accompanied by reluctance of the barium column to enter the jejunum, warrants a diagnosis of duodenal ileus. The extent of this condition and whether it is functional or organic can be studied further by roentgenograms taken in numerous positions, including the horizontal, oblique, and prone. In some instances the patient must be placed in the knee-chest position to relieve the obstruction.

Conservative management is sufficient in the less acute cases, although drugs do not appear to give relief. After fluoroscopy, the roentgenologist is often able to suggest the position most favorable for duodenal emptying. When obstruction is complete, or essentially so, duodenojejunostomy is indicated.

Two roentgenograms.

HERNIA

Diaphragmatic Hernias. Fidel Aguirre, O. López Fernández, M. Delgado Comas, O. Aguirre, and collaborators. *Bol. Col. méd. de la Habana* 8: 177-212, June; 225-266, July; 277-316, August 1957. (In Spanish) (Havana, Cuba)

This is a comprehensive monograph covering the entire subject of diaphragmatic hernias. The paper is high-lighted by significant and interesting experimental work on physiopathology and etiology. Besides a very full review of practically all aspects which previously have been treated in papers on the subject, a number of original observations and conclusions are presented.

Knowing that the intra-abdominal contents are equivalent to a liquid with the density of human serum, the authors made use of the free end of a swallowed duodenal tube to devise a sort of manometer. By this means it was possible to demonstrate the ef-

fective or equivalent level of the mass of the intra-abdominal contents, and to record it as a line drawn on the abdomen for purposes of reference. The method permitted studies of intra-abdominal pressure in various positions and conditions without puncture of the abdominal wall.

Intra-abdominal pressure was found to be affected by ascites, pulmonary emphysema, pneumothorax, phrenic paralysis, and anything affecting tension of the abdominal wall, such as congenital abnormality, inguinal or umbilical hernia, trauma, etc.

The stomach's gas bubble was found to have interesting significance. There usually is a state of equilibrium between the intragastric and intra-abdominal pressures. If intra-abdominal pressure is increased, belching ensues. If a patient goes into shock, air swallowing occurs, evidently as an attempt to re-establish intra-abdominal pressure.

It also became clear that to produce a diaphragmatic hernia there must be both a weak orifice and an increase in intra-abdominal pressure. In numerous experiments on dogs, surgical insufficiency was created in various diaphragmatic areas. It was noted that, unless the abdomen was bound, to increase intra-abdominal pressure, the hernias reduced and healed themselves.

An explanation is presented for the relatively high incidence of hiatus hernias over abdominal and inguinal hernias. Intra-abdominal pressure is exerted equally in all directions, and the umbilical and inguinal regions are habitually under positive pressure. However, the esophageal hiatus is under negative pressure and, if this area becomes exposed to increased pressure, its physiology is adversely affected more easily. Weakness, insufficiency, and finally visceral herniation may therefore follow increased abdominal pressure.

The authors dedicate considerable space to the subject of eventration. They state that, in addition to conventional x-ray and fluoroscopic methods and findings, the use of kymography and of pneumoperitoneum or pneumothorax can be very helpful in differential diagnosis. Secondary signs of eventration are a large stomach gas bubble, mediastinal displacement, and change in shape of the stomach due to rotation.

About half of the monograph is devoted to the subject of hiatus hernia; and the discussion on physiopathology of the lower esophagus is of special interest. With its sphincter mechanism, the lower esophagus constitutes a segment whose anatomy and physiopathology are separate from the rest of the organ. The esophagogastric segment has an expulsive function of two phases; (a) an ampullar phase, during which the ampulla distends and then contracts forcefully to push its contents into the vestibule; (b) a vestibular phase, wherein the vestibule fills and the longitudinal deep muscle fibers simultaneously contract to open the cardiac sphincter and the esophageal constrictor fibers. Finally, the mucosa is everted or protrudes; if lax, it may be displaced partially through the cardia.

These changes produce little supradiaphragmatic dilatations which have been confused with true hiatus hernia. Also, mucosal markings crossing the cardia may obscure the diagnosis, as the gastric and esophageal folds look alike. Simple protrusion or prolapse of mucosa occurs sometimes as a physiologic rather than an anatomic abnormality.

The true hiatus hernia may be diagnosed presumptively by elevation of the esophagogastric junction,

permitting reflux of barium; persistent dilatation and slow emptying of the ampulla; elevation of the ampulla and vestibule above the level of the right leaf of the diaphragm.

Tomography, sometimes in decubitus positions or after ingestion of food, thoracoscopy, esophagoscopy, presacral air injections, barium studies of the gastrointestinal tract, and pyelography are all offered as special diagnostic methods which may be needed to confirm diagnosis in certain selected cases.

Surgical repair of diaphragmatic hernias is discussed in detail.

One hundred fifty-eight figures.

DON E. MATTHIESEN, M.D.
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Diaphragmatic Hernia Through the Foramen of Morgagni. David P. Boyd and Bart F. Wooldridge. *Surg., Gynec. & Obst.* 104: 727-732, June 1957. (D. P. B., 605 Commonwealth Ave., Boston 15, Mass.)

Normally there exists in each leaf of the diaphragm a triangular space with its apex pointing toward the central tendon. This space is devoid of muscle fibers and is between the sternal and anterior costal attachments of the diaphragm. Herniation through these spaces was first described by Morgagni almost two hundred years ago and they became known as the foramina of Morgagni.

Herniation through the foramen of Morgagni occurs oftener on the right than on the left. It is acquired, in middle life, by overweight patients, usually female, subjected to rapid changes in intra-abdominal pressure, e.g., coughing. Symptoms are chiefly cardiorespiratory and gastrointestinal.

The diagnosis rests on the x-ray demonstration of a rounded, soft-tissue mass in the anterior thorax, obliterating the cardiohepatic angle. In the differential diagnosis other lesions common to the area must be considered—lipoma, teratoma, lymphoma, peripheral lung growth, hydatid disease, empyema, pleural and pericardial cysts. Adjacent lung may be atelectatic due to compression. The appearance of bowel loops in the area, when recognized, is diagnostic of intestine within the hernial sac. Barium studies of the gastrointestinal tract are helpful in establishing a diagnosis, as are pneumothorax and/or pneumoperitoneum on occasion. The diagnosis is more difficult if omentum alone is responsible for the soft-tissue shadow. It may be inseparable from the heart at fluoroscopy, necessitating exploration for diagnosis. Physical examination that reveals a succussion splash synchronous with cardiac systole is a highly suggestive finding.

Treatment consists of closure of the diaphragmatic defect through either the transabdominal or transthoracic route.

Details of 9 cases in 8 patients are included. In 1 case, two years after repair of a large right-sided hernia a left-sided hernia developed.

Six roentgenograms; 2 drawings; 1 table.

SAUL SCHEFF, M.D.
Boston, Mass.

THE MUSCULOSKELETAL SYSTEM

Chondrodysplasia Calcificans Congenita. H. Käser. *Schweiz. med. Wchnschr.* 87: 676-680, June 1, 1957. (In German) (Universitätskinderklinik, Bern, Switzerland)

Chondrodysplasia calcificans congenita, known also

as chondrodystrophia calcificans congenita, dysplasia epiphysialis punctata, chondroangiopathia calcarea, and congenital stippled epiphysis, is a systemic congenital disease affecting the cartilaginous portion of the epiphyses. It is a disturbance of calcification similar to that in chondrodystrophia foetalis. The diagnosis is primarily roentgenologic, based on stippled islands of calcium density in the cartilaginous epiphyseal portion of the bones, especially of the ankles and wrists. These islands tend to disappear after five to seven years. Associated anomalies are retarded development of the bones of the extremities, with foreshortening and flexion deformities, congenital bilateral cataracts, and hyperkeratotic dermatoses. About 50 per cent of the patients do not survive beyond infancy, because of intercurrent diseases. Only 49 cases have been reported so far.

The disease can be grouped among the congenital enchondral disturbances of ossification and the constitutional enchondral dysostoses. Females are predominantly affected, but etiology and pathogenesis are unknown. Treatment is only symptomatic and is confined mainly to orthopedic measures. The author presents the case of an infant with the typical roentgen findings of stippled epiphyses of long bones, especially of the ankles and wrists. Gradual diminution of the calcific stippling could be followed over a period of two years, so that at the age of thirty-three months the appearance was almost normal. There was also involvement of vertebral bodies, ribs, sternum, and pelvis. Of special interest was a persistent solitary suprasellar calcific focus believed to be a malformation of the right processus dorsalis sellae. Of further interest were flexion deformity of the lower extremities, formation of striae of the thighs, foreshortening of the right femur, macrocephaly, saddle nose, short neck, kyphoscoliosis of the thoracic spine, and lordosis of the lumbar spine. A bilateral congenital cataract was also present, which showed some regression while under observation.

Five roentgenograms; 2 photographs.

ERNEST KRAFT, M.D.
Northport, N. Y.

Dysplasia Epiphysialis Multiplex. Walter Levy, Harish Mazumdar, and Francisco Morales. *J. Pediatr.* 50: 724-729, June 1957. (Morrisania Hospital, 1230 Gerard Ave., New York 14, N. Y.)

A case of dysplasia epiphysialis multiplex in a 6-year-old boy is reported. Radiologic findings included irregularity in contour and calcification of both humeral heads and of the carpal and tarsal bones. Cystic changes were noted in the right glenoid. There were epiphyses for both femoral heads as well as the condyles; those for the femoral heads were irregular in appearance as were those for the metacarpals and metatarsals. The femoral heads were deformed, and the epiphyses united. The acetabula were also irregular in contour. The remainder of the skeletal examination was normal. A complete radiologic survey of the skeletons of the parents and siblings revealed no abnormality.

This syndrome must be differentiated from achondroplasia, hypothyroidism, chondrodystrophies, endocrine conditions, congenital dwarfism, osteochondrosis juvenilis, cretinoid epiphysial dysgenesis, and hypopituitary dwarfism. The characteristic roentgenologic findings in the epiphyses distinguish dysplasia epiphysialis multiplex from other conditions. The etiology is

unknown. No treatment available influences the course of the disease.

Five roentgenograms.

Thyrogenic Osteodystrophy with Endocrine Activity in Metastasizing Microfollicular Thyroid Adenoma. E. Uehlinger. *Schweiz. med. Wchnschr.* 87: 683-688, June 8, 1957. (In German) (Pathologische Institut der Universität Zurich, Zurich, Switzerland)

This is an autopsy report, with discussion, of the case of a 78-year-old female who died of a metastasizing recurrent nodular goiter. Eleven years previously an apparently benign struma nodosa compressiva microfollicularis had been resected. The autopsy revealed (1) a microfollicular thyroid adenoma with metastatic lesions in regional lymph nodes and lungs and (2) generalized osteodystrophy. The marked bone changes, not recognized during life, are the main topic of this article.

From the histologic study it could be concluded that the metastasizing thyroid adenoma had developed only gradually and had functioned as an endocrine organ, with secretion of thyroxine. This hormone was most likely responsible for the development of the osteodystrophy.

The generalized skeletal involvement in thyrogenic dystrophy is characterized by (1) osteoporosis, (2) dissecting fibro-osteoclasia, and (3) osteomalacia. It is identical with von Recklinghausen's original description of osteomalacic dystrophy associated with Basedow's disease but differs histologically and pathogenetically from osteodystrophy in hyperparathyroidism. In hyperparathyroidism the osteitis fibrosa is a secondary response to renal depletion of calcium and phosphorus. There are hypercalcemia and hypophosphatemia and, roentgenologically, a washed-out or ground-glass appearance of osseous texture. On the other hand, thyroid osteodystrophy (or osteitis fibrosa) is the result of prolonged overproduction of thyroxine with accelerated physiologic turnover of bone formation.

Seven photomicrographs; 1 table.

ERNEST KRAFT, M.D.
Northport, N. Y.

Osteo-onychodysplasia. Willard H. Love and David D. Beiler. *J. Bone & Joint Surg.* 39-A: 645-650, June 1957. (The George F. Geisinger Memorial Hospital, Danville, Penna.)

Osteo-onychodysplasia (Turner's syndrome) is a familial, developmental condition in which dystrophy of the nails is the most frequent deformity. This varies from full absence of a nail to one that is fairly normal except for being too thin. The thumb is usually the most affected with the nail of the fifth digit the least so. Associated conditions include hypoplasia of the patellae, which are usually displaced superiorly and laterally, genu valgum, and weakness of the quadriceps femoris. Secondary arthritic changes are also frequently seen in the knee region. The elbow joint may show thickening of the distal portion of the humerus and prominence of the medial epicondyle. The radial head is small and usually subluxated or dislocated posteriorly. Limitation of motion at the elbow is common. Posterior iliac horns are also frequently found in this situation. Less common manifestations include pes planus, prominence of the medial malleoli, prominence of the distal end of the clavicle, underdevelopment of the scapula and humeral head.

The present report describes this condition and shows typical roentgenograms and photographs from 4 patients, 3 of whom were in one family.

Ten roentgenograms; 3 photographs.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Reticulohistiocytosis (Lipoid Dermato-Arthritis).

Robert P. Warin, Clifford D. Evans, and Mark Hewitt, with Reports and Discussions of Pathology by A. L. Taylor and C. H. G. Price and of Radiology by J. H. Middlemiss. *Brit. M. J.* 1: 1387-1391, June 15, 1957. (United Bristol Hospitals, Bristol, England)

This is a report of 4 cases of unusual skin eruptions and arthritis which occurred in women of various ages. Twelve similar cases, recorded in the literature under various titles, are presented in summary. The arthritis was similar to rheumatoid arthritis but differed in that there were greater bone destruction and less cartilage destruction. The terminal interphalangeal joints were markedly involved. Some unusual joints such as the posterior articulations of the lumbar spine and the costotransverse joints were affected. The connective tissue attachments to various bones also showed involvement.

The skin lesions were yellowish-brown papules over the backs of the hands, forearms, face, and other areas. These lesions varied greatly in distribution. Purple nodules were often present over bony prominences. There were instances of xanthelasma palpebrarum and tendon sheath swelling, and papules of the mucous membrane may occur.

Histologic examination of the involved tissues showed giant cells filled with fat-like material. The blood cholesterol and laboratory findings were usually not remarkable. The condition varied in severity and differed in course, with progression in some cases and resolution in others. The clinical course also varied; 4 patients died, while others improved.

The disease bears resemblances to xanthomatous disorders, giant-cell synoviomias, granular cell myoblastomas, and rheumatoid arthritis and has been described under the term "reticulohistiocytosis." "Lipoid dermatitis" appears preferable.

Three roentgenograms; 3 photomicrographs; 3 photographs; 1 table.

PAUL MASSIK, M.D.
Quincy, Mass.

Spine Fusion in Young Children. A Long-Term End-Result Study with Particular Reference to Growth Effects. Halford Hallock, Kenneth C. Francis, and James B. Jones. *J. Bone & Joint Surg.* 39-A: 481-491, June 1957. (H. H., 180 Fort Washington Ave., New York 32, N. Y.)

In order to determine the effect of fusion on the growth of the vertebrae in man, the authors studied 15 patients upon whom a Hibbs fusion had been done. The patients were followed from early childhood into adult life. The fusion areas were in the following portions of the spine: (1) thoracic, 7 cases; (2) thoracolumbar, 5 cases; (3) lumbar, 3 cases.

The fusions were done for tuberculosis. They were all successful and in every instance the disease was healed. Thus a unique opportunity was afforded to observe growth changes. The intervertebral disk spaces were narrowed. A trapeziform development of the end-vertebrae was noted and underdevelopment of the fused vertebrae in both sagittal and frontal planes was noted.

The authors describe in detail their technic for measuring the vertebrae and explain their method of correction for distortion.

It was learned that considerable variation in growth occurred even in individuals of nearly the same age when the operation was done. On an average, the entire fusion area grew anteriorly 37 per cent less and posteriorly 45 per cent less than normal vertebrae. The fused normal vertebrae grew 23 per cent less anteriorly and 36 per cent less posteriorly than adjacent normal unfused vertebrae.

The article is well illustrated by figures and charts. These are helpful in visualizing the method of measurement used, the magnitude and location of the growth disturbances noted, and the morphologic changes produced in the spine by fusion.

Thirteen figures including 2 roentgenograms; 2 tables.

H. C. JONES, M.D.
Grand Rapids, Mich.

Analysis of the Foot in Infants: The Radiographic Criteria and Clinical Aspects. William S. Hatt and Lawrence A. Davis. *South. M. J.* 50: 720-724, June 1957. (L. A. D., 226 E. Chestnut St., Louisville, Ky.)

Physicians dealing with the care of infants are often confused by the terms used by the orthopedic surgeon in regard to the foot. The complexity of motion at the ankle and subtalar joints, not to mention that of the legs and hips themselves, are easily misinterpreted. Terms like varus, valgus, cavus, etc., leave the pediatrician, often the radiologist, as well as the orthopedist, a bit in the dark. In a previous paper the authors set forth criteria for the radiologist (*Radiology* 64: 818, 1955); in the present one they attempt to bring order out of chaos for the clinician.

An analysis of the infant foot based on the standardized technic is presented. The so-called normal infant foot in its neutral position, clubfoot, rocker deformity, flatfoot, metatarsus varus, metatarsus valgus, and pes cavus are discussed from the standpoint of the talocalcaneal angle both in lateral and anteroposterior projections. The inferior cortical line of the fifth metatarsal and calcaneus, midshaft lines of the first and fourth metatarsals, and the midshaft lines of all the metatarsals are utilized in analysis of the forefoot.

Since the conditions discussed may be considered as positional changes of otherwise normally developed bones and joints of the infant foot, it is felt that comprehensive analysis of these positional changes is essential for their accurate diagnosis and treatment, as well as in future investigation.

GYNECOLOGY AND OBSTETRICS

Hysterosalpingography with Endografin. P. McCann and D. N. Menzies. *J. Obst. & Gynaec. Brit. Emp.* 64: 416-418, June 1957. (Liverpool Royal Infirmary, Liverpool, England)

The authors have used the water-soluble contrast medium Endografin for hysterosalpingography in 20 cases. This medium is said to be chemically identical with Biligrafin, though the concentrations differ. Less discomfort was experienced with Endografin than with other media. No general or local reactions were encountered. The outline of the uterine cavity and of the fallopian tubes was comparable in density with that obtained by other means. In particular, the details of the isthmus and internal os were well demonstrated.

In the absence of liver damage, Biligrafin, 90 per cent, injected intravenously, is excreted through the bile ducts into the bowel. The more concentrated Endografin used for hysterosalpingography is also excreted in this manner. It was found that the substance reached the common bile duct in one hour, the cystic duct and gallbladder in two hours, and the small bowel in three hours. Apparently absorption does not occur from the uterine cavity or from peritoneal pockets at a rate sufficient to produce a good cholecystogram, but only from the free peritoneal cavity. For this reason, the authors accept a good gallbladder shadow, at four hours or earlier, as evidence of tubal patency and intraperitoneal spill. Conversely, the absence of a cholecystogram suggests blocked tubes, but only if liver function is normal. In 4 cases in which tubal patency was not demonstrated, no cholecystogram was obtained. In another case there was doubtful spill and the gallbladder shadow was weak and was not present at four hours. All of the remaining 15 cases were found to have full intraperitoneal spill on fluoroscopy; in 2 the gallbladder was not examined at four hours but in 13 cases it was clearly seen.

Six roentgenograms.

Ossification Centres as Evidence of Foetal Maturity. Duncan Murdoch and Ian Cope. *J. Obst. & Gynaec. Brit. Emp.* 64: 382-384, June 1957. (Hammersmith Hospital, London, England)

An estimate of the degree of maturity of a fetus is often required in the management of maternal hypertension, pre-eclampsia, antepartum hemorrhage, hydramnios, and other disorders of pregnancy. In such conditions, roentgenography is of great service, both in the search for signs of fetal malformation and in the estimate of the general degree of ossification, the size of the fetus, and the size of the fetal head as indications of the progress of fetal development.

When satisfactory roentgenograms show details of the region of the knee and ankle joints, the presence and size of the ossification centers provide the radiologist with further evidence for an opinion on the development of the fetus. In the authors' experience, the table of average dates of appearance of ossification centers presented by Chassar Moir (in Browne, F. G., and Browne, J. C. McC.: *Antenatal and Postnatal Care*, 8th ed., 1955, p. 625) is a valuable guide. The dates given are merely averages, subject to much individual variation. It may therefore be useful to know the range and variety of appearances which may be expected at maturity, and these the authors have estimated after the radiographic examination of 100 apparently mature infants delivered from healthy mothers within three days of the predicted date. Roentgenograms were obtained shortly after birth.

The epiphysis of the lower end of the femur was present in 99 of the 100 cases and was judged to be sufficiently well calcified to be visible radiographically before birth in at least 78 cases.

The epiphysis of the upper end of the tibia was present in 72 of the 100 cases and was well developed and well calcified in 39 cases.

The cuboid was ossified in 28 of the 100 cases and well developed and well calcified in 13. Its multicentric ossification was noted.

The absence of any one center is not incompatible with maturity and marked development does not, of necessity, mean a prolongation of pregnancy.

A Possible Method of Foetal Sex Determination. A. M. Stewart and John McKenzie. *Brit. M. J.* 1: 1396-1398, June 15, 1957. (A. M. S., Aberdeen Royal Infirmary, Aberdeen, Scotland)

The authors describe a possible method of determining the sex of a fetus *in utero*. In 10 instances, which represented 1.3 per cent of all the pregnancies referred for x-ray examination in one year, a coronal cleft vertebra (or vertebrae) was observed in the lumbar spine. In every instance the child was a male. The defect is seen only in a true lateral position. A large ventral and a small dorsal center of ossification are demonstrable, with an ovoid cleft between them, which may show varying degrees of bridging.

This cleft must be differentiated from the synchondrosis between the ossified neural arch and the centrum, which lies further dorsally. A possible explanation is invasion of the cartilage body by vessels and ossification in the vicinity of the terminal ramifications. This appearance is normally seen in 33 per cent of fetuses before the twenty-eighth week of gestation, with no male preponderance. It is not believed to have any pathological significance.

Two roentgenograms. PAUL MASSIK, M.D.
Quincy, Mass.

THE GENITOURINARY SYSTEM

On Renal Damage Due to Aortography and Its Prevention by Renal Tests with Reports of Five Cases of Severe Renal Damage. Nils P. G. Edling and C. G. Helander. *Acta radiol.* 47: 473-480, June 1957. (Karolinska Sjukhuset, Stockholm, Sweden)

In 320 aortographic examinations performed at the Karolinska Sjukhuset there were 13 kidney reactions. In 8 cases the signs of renal insufficiency were mild, but in 5 impairment was severe. In 2 of the latter group double injections were made (50 ml. Umbradil 50 per cent in Case I; 40 ml. Umbradil 50 per cent and 30 ml. Umbradil 70 per cent in Case II), with femoral compression.

The complications consisted in anuria-oliguria, proteinuria, and elevated N.P.N., which subsided within ten days to two weeks. In Case II the maximum specific gravity of the urine was still 1.016 after two months. In the third case, most of a moderately large but highly concentrated dose of contrast medium (30 ml. of 70 per cent Umbradil) passed into the renal arteries owing to occlusion of the distal part of the aorta. Function had returned to normal in a week. In the 2 remaining cases renal function was impaired before aortography and further damage followed a standard injection technic, but eventually function returned to pre-injection levels.

After discussion of various methods of diagnosing renal function impairment, the authors conclude that candidates for aortography may be classified into 3 groups on the basis of a specific gravity test. The first group, with a concentrating power of 1.026 or better, may be considered to have an adequate safety factor. Patients in the second group, in which the concentrating power is between 1.020 and 1.026, should have a urea clearance test. If the clearance is one-half the normal or less, great caution should be exercised, as there is grave risk. The third group comprises those with such impairment of concentration (under 1.020) and diminution of urea clearance, with increased N.P.N., that angiography is contraindicated.

Additional caution is advised in patients with a solitary kidney. Here accurate clearance tests must supplement the specific gravity estimates. If the figures indicate a capacity of only one kidney or less, angiography is contraindicated.

GEORGE L. SACKETT, M.D.
Cleveland, Ohio

Intrarenal Aneurysm of the Renal Artery: Case Report. Gilbert I. Smith and Virgil Erickson. *J. Urol.* 77: 814-817, June 1957. (710 Medico-Dental Bldg., San Jose 13, Calif.)

Following a few comments on renal artery aneurysms in general, a case is recorded. The patient was a 43-year-old Mexican female who entered the hospital because of sudden onset of dull, constant, right flank pain, with radiation to the right inguinal and thigh regions. A similar episode, of brief duration, had occurred one year previously. Physical examination was essentially negative except for mild hypotension. Laboratory studies indicated a moderate nonspecific anemia. At intravenous urography a small pressure defect was seen in the lower part of the right kidney, with inferior displacement of the lower calyceal group. No intrarenal calcification was evident. Translumbar aortography showed immediate filling of a sac-like structure, 2.5 cm. in diameter, arising from the right renal artery in the lower pole of the kidney. An immediate follow-up film indicated complete emptying of this structure. The patient was treated by right nephrectomy. The kidney was found to contain a rounded cyst-like structure with endothelial lining, arising from an anomalous branch of the renal artery. Since all vascular layers were evident histologically, the lesion by definition was a true aneurysm. It was presumed to be congenital.

Three roentgenograms; 1 photograph.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Retrocaval Ureter. Luis F. Rodríguez Molina and Rafael Molina Sabucedo. *Radiologia, Panama* 7: 115-119, June 1957. (In Spanish) (L. F. R. M., Calle 2 N° 607, Vedado, Havana, Cuba)

The literature for the years 1893 to 1951 was found to contain 44 case reports of retrocaval ureter. Of these 44 cases, 12 were incidentally discovered at surgery; 6 were diagnosed before operation and 22 at autopsy. Four cases are unaccounted for.

Clinical symptoms of retrocaval ureter are not pathognomonic. When present, they correspond to those of pyelonephritis. The best means of accurate diagnosis is pyelography. This may reveal medial displacement of the ureter at the level of L-3 to L-5, giving the characteristic double curvature. The renal pelvis is funnel-shaped.

Treatment is surgical. Different procedures are reviewed by the authors, who advise conservative surgery when the kidney is not destroyed.

The authors present the first case to be recorded in Cuba with a preoperative diagnosis. The surgical technic used in this particular case included resection of the dilated upper third of the ureter, removal of the segment from behind the vena cava, and suture of the distal segment of the ureter to the renal pelvis. Before the patient was discharged, pyelography showed a normal course of the ureter.

Two roentgenograms. L. ALFONSO VARELA, M.D.
St. Vincent's Hospital, New York

TECHNIC

Electronic Amplification of Fluoroscopy in the Private Office. Alfred O. Miller. *South. M. J.* 50: 665-669, May 1957. (564 Francis Bldg., Louisville 2, Ky.)

The author discusses the use of an image-amplifying fluoroscope in the private practice of radiology. He has found it to offer three distinct advantages over the conventional fluoroscopic apparatus: (1) a brighter and sharper fluoroscopic image; (2) less radiation to patient and operator; (3) the convenience of good fluoroscopy without the need for dark adaptation.

The ability to produce a brighter image will increase the usefulness of fluoroscopy. Altered physiologic action, as well as changes in morphologic contour, will be evaluated in making a roentgen diagnosis. If one can study the pulsation of smaller pulmonary vessels, visualize the gallbladder and its ducts during the emptying process, and see the intravenous contrast medium passing down the ureters from the kidneys, it seems logical that these observations will contribute to a better diagnosis. Lesions of the gastrointestinal tract are demonstrable with the image amplifier that cannot be visualized by ordinary methods. The advantages in fluoroscopy of the lungs are somewhat doubtful, and it is unlikely that here fluoroscopy will ever be a substitute for a good roentgenogram. Cardiac fluoroscopy is somewhat difficult until one becomes familiar with the instrument. Study of the paranasal sinuses is a useful adjunct to chest fluoroscopy; clouding, polyps, fluid levels, and gross thickening of the mucous membrane may be seen. Study of the cervical spine is possible, and actual luxation between two vertebral bodies has been observed during flexion and extension.

A comparison of the factors used in conventional fluoroscopy and with the image amplifier indicate an 80 per cent decrease in skin exposure to the patient and 88 per cent decrease in exposure to the male gonads. The exposure to radiologists after an hours continuous fluoroscopy decreased from approximately 550 mr. to approximately 23 mr.

Disadvantages of the amplifying fluoroscope are the high initial cost, the small size of the field, and the physical weight and bulk of the instrument.

The author concludes that, while this instrument will not make a good radiologist out of a poor one, it will increase the diagnostic yield of the careful and conscientious fluoroscopic observer.

Adaptation of an Existing Screening Stand for Use with a Philips Image Intensifier. J. H. Stranger and T. J. W. Mallin. *Brit. J. Radiol.* 30: 331-332, June 1957. (East Glamorgan General Hospital, Pontypridd, Glamorgan, Wales)

An image intensifier offers certain advantages over a fluorescent screen in gastrointestinal work, producing an image of increased brilliance and definition with less radiation to the patient. Relatively small field size and difficulty in combining a spot-film device without making manual palpation impossible have been limitations of image intensification and equipment.

In this article the authors describe the mounting of a Philips image intensifier on an existing screening stand in such a way as to allow for manual palpation and spot-filming.

One photograph; 1 diagram.

RICHARD P. STORRS, M.D.
Los Angeles, Calif.

A Comparative Study of Xeroroentgenography and Routine Roentgenography in the Recording of Roentgen Images of Bone Specimens. Crawford J. Campbell, John Roach, and Andres Grisolia. *J. Bone & Joint Surg.* 39-A: 577-582, June 1957. (C. J. C., 721 Madison Ave., Albany 8, N. Y.)

Xeroroentgenography is a process in which an electrostatic image is produced on a metallic plate coated with a semiconductor such as selenium. This electrostatic image is then made visible by placing finely divided powder granules on the plate. [For an account of the technic see *Arch. Surg.* 69: 594, 1954. *Abst. in Radiology* 65: 312, 1955.] A permanent record of image can be obtained by photographic methods.

In using this method it has been noted that along the dividing line between a region of high and low x-ray

transparency there occurs a distortion of the powder, resulting in an accentuation of the normal contrast.

The authors used 1 cm. thick sections of bone and joint specimens to evaluate this increased contrast by comparing the conventional roentgenogram with the xeroroentgenogram. It was found that the soft-tissue detail is more pronounced in the xeroroentgenogram than on the routine film, a feature which is either an aid or hindrance, depending upon the nature of the tissues being studied.

Several illustrations are presented showing the detail seen on the roentgenogram, the xeroroentgenogram, and the pathologic section.

Fifteen figures, including 4 roentgenograms.

J. A. GUNN, M.D.
Grand Rapids, Mich.

RADIOTHERAPY

Results of Radiotherapy of Tonsillar Tumors. Horst Hillger and Hellmut Schwenkenbecher. *Strahlentherapie* 103: 48-59, May 1957. (In German) (Strahlenklinik der Universität, Marburg/Lahn, Germany)

The authors record their results in the treatment of 34 patients who, from 1945-1955, were under their care because of malignant tonsillar tumors. The incidence was about equal in the two sexes, in contrast to the experiences of other authors, who report a predominance in males.

At the onset of symptoms the average age of the females was 59.8 years and of males 65.3 years. The youngest female patient was twenty-three years old and had a sarcoma; the oldest was seventy-seven and suffered from a carcinoma. The youngest male patient was forty-two and the oldest seventy-nine years of age.

Of the 34 patients, only 7 were free of metastasis when treatment was started. Metastasis was present in 12 of the 13 sarcoma cases when the diagnosis was established, indicating the high incidence of metastasis in sarcoma.

The cases were classified in accordance with the rules established by the Seventh International Congress of Radiologists.

Stage 1: Tumor localized to tonsil. No lymph-node metastasis.

Stage 2: Infiltrative growth of tumor with invasion of the fauces but not extending beyond them. Restricted mobility of tonsil. No lymph-node metastasis.

Stage 3: Tumor invasion of surrounding tissue or palpable but not fixed lymph nodes.

Stage 4: Tumor invasion of surrounding tissue and neighboring organs or extension to skin or enlarged and fixed lymph nodes.

Twenty-two of the 34 patients had Stage 3 lesions.

In most of the patients the first symptoms were observed one to four months prior to the institution of therapy, and regional lymph nodes were already present in about 80 per cent. It was the enlarged nodes which usually led the examining physician to the detection of the primary tonsillar tumor. Repeated biopsy was often necessary to establish the diagnosis.

Of the 34 patients, 26.5 per cent lived three years, and 14.7 per cent were still alive five years after the onset of symptoms.

The following treatment is recommended by the

authors: X-ray therapy through three portals, with additional posterior neck and submental fields in extensive processes. Combination of external x-ray irradiation with interstitial or contact radium therapy, frequently with neck dissection.

Two diagrams; 4 tables.

HERBERT C. POLLACK, M.D.
Chicago, Ill.

Life Expectancy in Struma Maligna. Georg Ostapowicz and Hans-Joachim Ramthun. *Strahlentherapie* 103: 298-304, June 1957 (In German) (Chirurgische Universitätsklinik der Charité, Berlin, Germany)

The life expectancy was statistically surveyed in 75 cases of malignant struma observed since 1938. The cases are grouped according to differentiation of tumor cells. Adenoma and papilloma are considered relatively benign; there is absence of destructive growth, and metastatic spread occurs only occasionally at a late stage. The five-year survival rate for this group is 90 per cent. Adenocarcinoma without metastatic spread shows a 50 per cent survival rate, but with metastatic spread the rate is only 35 per cent. In solid carcinoma the prognosis is unfavorable. In 5 cases of carcinosarcoma there was a single three-year survival.

In endemic goiter areas malignant struma occurs seven times more frequently than in goiter-free districts. In 35 cases operated upon by Wolf (*Zentralbl. f. Chir.* 82: 303, 1957) a goiter preceded the malignant growth by two to nine years. Symptoms of sudden dizziness and a sense of pressure with radiating pain to the head, neck, and shoulder are not characteristic. More typical are rapid growth of the goiter, hoarseness, and pain on swallowing. Signs of hyperthyroidism are frequently absent. Metastatic spread through blood and lymph channels is present in 90 per cent of the cases. The site of predilection is the lungs. Less frequently spread is noted in the skeleton, liver, adrenals, and intestinal tract. Metastatic involvement of the kidneys, heart muscle, dura mater, pancreas, and testicles is rare.

In 60 per cent of the authors' series the trachea was either narrowed, displaced, or surrounded by the tumor. In 21 per cent the esophagus was encroached upon, and in 13.3 per cent the vessels of the neck were invaded. The trachea was perforated in 9.3 per cent, the esophagus in 6.6 per cent, and the skin in 5.3 per cent. In 20 per cent a tracheotomy was required.

In this series of 75 cases, 46 were operated upon. Of 25 patients surviving one year 9 (36 per cent) lived for five years, but only those who had undergone radical or subtotal operation and radiotherapy.

It is concluded that for obtaining a favorable survival rate an early diagnosis by biopsy or the radioiodine test is a prerequisite. Even in the far advanced hopeless cases radical therapy tends to improve the life expectancy.

Five tables.

ERNEST KRAFT, M.D.
Northport, N. Y.

The Technic of Moving Beam Therapy in Carcinoma of the Esophagus. Ernst Kahr. *Strahlentherapie* 103: 249-256, June 1957. (In German) (Zentral-Röntgeninstitut des Landeskrankenhauses Graz, Graz, Austria)

Rotational therapy has many advantages over stationary deep roentgen therapy, being especially successful in the management of esophageal carcinoma. A tumor dose of 4,000 to 6,000 r, in fractions of 150 to 200 r is usually planned. Occasional increase up to 10,000 r has failed to improve the results.

From a practical standpoint one has to calculate a metastatic spread to the regional nodes and the efferent lymphatic pathways. In the proximal third of the esophagus, the tracheal and deep cervical nodes are likely to be involved; in the distal two-thirds the bronchial and posterior mediastinal nodes downward to the gastric, hepatic, and lumbar areas are frequent sites of metastatic spread.

The author's material consists of 36 cases observed from 1954 until 1956. All were far advanced and inoperable. Radiation therapy was directed not only to the primary tumor site, but also to the regional lymphatics. The daily depth dose in this series was reduced from 200 to 150 r so as to lessen lethal complications such as tumor necrosis with suppuration and perforation into the mediastinum, the bronchial tree, and the blood vessels. A second series was considered inadvisable, but six to eight weeks after completion of the first series the lymphatics were treated prophylactically with stationary deep roentgen therapy.

In 43.7 per cent of the cases there was improvement of swallowing. The average survival of five patients still living was 12.6 months. The average survival, including incompletely treated cases, was 6.4 months, which represented an improvement over previous results. In all operable cases preoperative radiotherapy of the tumor and regional lymphatics was instituted.

Five roentgenograms; 2 photomicrographs; 1 drawing; 2 tables.

ERNEST KRAFT, M.D.
Northport, N. Y.

Roentgen Findings in Treated Metastatic Bone Lesions from Breast Cancer, with Special Consideration of Combined Roentgen and Sex Hormone Therapy. Klaus Pfeiffer. *Strahlentherapie* 103: 267-271, June 1957. (In German) (Universitäts-Röntgen-Institut, Leipzig, Germany)

Hormone therapy of advanced carcinoma of the breast can be considered only a palliative measure. To improve its effectiveness, various additional measures are therefore necessary. The author reports the effect of combined local irradiation, roentgen castration, and a maintenance dose of testosterone on osseous metastatic lesions.

The material consists of 122 fatal cases followed during the past four years. Only cases are included in

which hormone therapy was given for at least two months. The following effects on bone changes were observed: (1) sclerosing of metastatic lesions originally not visualized; (2) normalization of bony texture in osteoplastic metastatic lesions; (3) gradual reossification of osteolytic foci.

Sclerosing of metastatic bone lesions was observed in 54 per cent, which represents an improvement over results in less radically treated cases. A good response was noted regardless of the histologic type and grading. Only cases with liver involvement failed to respond favorably.

With the combined therapy, a low maintenance dose of testosterone—50 mg. intramuscularly two or three times weekly—was possible. Thus the toxic effects were greatly reduced, and secondary hypercalcemia was observed in only 2 cases. An analgesic effect was noted in 70 per cent, and patients in the terminal stage were made more comfortable than heretofore.

Serial roentgenograms illustrate the response of the bone lesions to the combined therapy.

Thirteen roentgenograms; 3 tables.

ERNEST KRAFT, M.D.
Northport, N. Y.

Multiple Myeloma: Diagnosis and Management in a Series of 57 Cases. John J. Kenny and William C. Moloney. *Ann. Int. Med.* 46: 1079-1091, June 1957. (W. C. M., 818 Harrison Ave., Boston 18, Mass.)

Pain, anemia, and weight loss were among the more common findings in the author's series of 57 cases of multiple myeloma. The disease occurs a little more frequently in males and is seldom seen before the age of thirty. Less common manifestations were nausea, vomiting, bleeding tendency, and enlargement of the liver and spleen. The pain may be due to an expanding lesion in bone, a pathological fracture, or nerve root compression.

The typical x-ray findings are multiple osteolytic areas, without osteoblastic reaction, especially in the ribs, sternum, clavicle, and skull; diffuse osteoporosis may be the only manifestation. Only 5 patients in the authors' series had no demonstrable bone changes.

Laboratory studies are important: demonstration of hyperglobulinemia, albuminuria, Bence-Jones proteinuria, anemia, and finally myeloma cells in the bone marrow.

X-ray therapy is usually of value in relief of bone pain locally, while urethan is at present the chemotherapy of choice. The course of the disease varies, but it is invariably fatal.

Four figures; 1 table. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Urethan in the Treatment of Multiple Myeloma. Mario Gaitán Yanguas. *Radiología*, Panama 7: 111-114, June 1957. (In Spanish) (Bogotá, Colombia)

The author treated 4 patients, with multiple myeloma by urethan plus deep x-ray therapy. Three of the group responded favorably. They were relieved of pain, and weight gain was noted, as well as improvement in blood chemistry and the radiographic picture. They had lived, at the time of the report, nine, seventeen, and nineteen months, respectively, after admission. One patient died six months after the first visit due to a superimposed uremia. The total dosage of urethan was between 90 and 502 gm., with an average of 3 gm. daily for thirty-five to one hundred sixty-five

days. The average deep therapy dose was 2,210 r Dn over the areas treated.

L. ALFONSO VARELA, M.D.
St. Vincent's Hospital, New York

Exenteration Operations in the Treatment of Advanced Pelvic Cancer. R. Gordon Douglas and William J. Sweeney. *Am. J. Obst. & Gynec.* **73**: 1169-1182, June 1957. (New York Hospital and Cornell University Medical College, New York, N. Y.)

This paper is a critical review of pelvic exenteration in a large university hospital with a well balanced obstetrical and gynecological service, where treatment of cancer is but one phase of activity. A detailed description of the age, postradiation and surgical history, preoperative evaluation, operative and postoperative courses, pathology, and follow-up of 23 patients undergoing this operation from 1948 to 1954 is presented.

One patient with carcinoma of the ovary, 1 with carcinoma of the urethra and 1 with carcinoma of the endometrium had had no previous irradiation. Eighteen patients with carcinoma of the cervix and 2 patients with carcinoma of the endometrium had been irradiated. Except for the carcinoma of the urethra, all the exenterations were done following failure of radiation therapy, radiation therapy and less radical surgery, or surgery alone.

Of the 23 patients, 16 (69.5 per cent) are dead, with 7 dying in the first year and 7 in the second year. Two of 10 (20 per cent) survived five years. One patient died on the sixth postoperative day, a surgical mortality of 4.3 per cent. In the group there were 68 postoperative complications; 78 per cent of the patients had urinary tract infections, and 74 per cent had bilateral hydronephrosis.

The literature is reviewed and the authors' experience is compared with similar published series.

This form of therapy may be indicated in a very limited number of patients with advanced pelvic cancer after failure of radiation, radiation and surgery, or surgery alone. Such a procedure should be undertaken only with the basic idea of cure, not palliation. It is not to be attempted by all gynecological surgeons in any and every hospital. The institution must be willing to assume the financial burden as well as the major responsibility for rehabilitation, readmission, and perhaps long-term care of these unfortunate individuals. The immediate postoperative hospital stay averaged 45.4 days per patient. Statistics never indicate the full extent of what this procedure means in terms of "living" versus "survival." For a limited number of patients the long-term "living" has appeared to be good, but for a much larger number the "survival" has been extremely difficult and discouraging.

Fourteen tables. ROBERT L. EGAN, M.D.
University of Texas, Houston

The Results in Carcinoma of the Cervix Uteri Treated with Radiotherapy at the Queensland Radium Institute in the Period 1945-1950. E. Harrison. *Proc. Coll. Radiologists Australasia* **1**: 25-28, June 1957. (Queensland Radium Institute, Brisbane, Australia)

This report on 361 cases of carcinoma of the cervix is believed to include practically all patients in Queensland who suffered from this disease between 1945 and 1950. The age incidence was not unusual; the youngest patient was twenty-one and the eldest eighty-eight years of age. One hundred and fifty-six patients were

alive and well five years or more from the time of treatment, a 43 per cent five-year survival rate.

A clinical staging of cases was adopted. There were 2 Stage 0 cases, both with survivals of over five years; 100 Stage I cases, with 63 per cent five-year survivals; 120 Stage II cases with 49 per cent five-year survivals; 97 Stage III cases, with 12 per cent five-year survivals; 24 Stage IV cases, with 4 per cent five-year survivals. Eighteen cases were unstaged.

All 361 cases were treated by radiation. Usually, in the late Stage III and IV cases treatment was palliative, with deep x-ray therapy only, though, if practicable, vaginal and uterine radium sources were used, with a lower than usual dose level. Most of the patients received intracavitary radium and deep x-ray therapy. The Manchester method of radium treatment was used, with a dose of 7,000 r at Point A (6,500 r if radium was to be supplemented by deep x-ray therapy). The intra-uterine tube contained either 10, 20, or 25 mg., depending on length. The ovoids contained 15, 20, or 25 mg. of radium. They were placed in the lateral fornices and, when the size of the vagina permitted, were separated by 1 cm. All radium insertions were checked radiographically.

Deep x-ray therapy through two opposing fields over the pelvis was given to bring the dose at point "B" to 4,500 r, with lead shielding placed to protect the highly dosed cervical area.

Where the routine treatment was impossible, as in a contracted vagina, one ovoid only was used, or two ovoids in tandem. The latter is useful for a growth which has spread down the vagina.

Vaginal contraction is an after-effect of treatment. It can be prevented to some extent by breaking down vaginal adhesions which form in the early months following treatment. Rectal and intestinal irritation can be troublesome during and shortly after treatment, but usually ceases within a few weeks. No fistulas occurred in the disease-free cases, but rectovaginal and vesicovaginal fistulas occurred in 6 cases in which there was carcinomatous extension to the vagina. These 6 patients all died within a few months after the development of the fistulae.

There were 19 patients with adenocarcinoma of the cervix, 5 per cent of the total number. Of these, 70 per cent survived five years without disease. Sixteen were treated radically by radium and deep x-ray therapy and 12 of these, plus 2 who were treated by hysterectomy followed by palliative radiotherapy, were alive and well for five years and more, which appears to indicate that adenocarcinoma of the cervix is a radiocurable growth.

Of 15 patients with carcinoma of the cervical stump, 47 per cent were alive and well after five years. All these received deep x-ray therapy and vaginal radium; where practicable, 10 mg. of radium were inserted in the canal of the cervical remnant. Fifteen cases of unsuspected carcinoma of the cervix were found following hysterectomy for other reasons. The five-year survival in this group was 60 per cent.

Three tables. JOHN P. FOTOPoulos, M.D.
Hartford, Conn.

Carcinoma of the Cervical Stump. David G. Decker, Arthur B. Hunt, Robert E. Fricke, and Gunard A. Nelson. *Am. J. Obst. & Gynec.* **73**: 974-981, May 1957. (Mayo Clinic, Rochester, Minn.)

Ninety-eight cases of carcinoma of the cervical stump, seen from 1940 through 1949, are reviewed. This rep-

resents an incidence of 6.7 per cent of the total cases of carcinoma of the cervix. There were 14 "coincident" cases in which the diagnosis was established within two years following subtotal hysterectomy; the remaining 84 "true" cases were diagnosed following that two-year interval. The usual reasons for the subtotal hysterectomy are listed.

The lesions were independently staged by a gynecologist and radiologist with knowledge of the difficulty in staging such lesions accurately in the pelvis markedly altered by previous disease and by surgical treatment. Of 60 "true" cases of squamous-cell carcinoma (adenocarcinoma and one unknown not staged), 35 were of Stages I and II and 34 of Stages III and IV. In these there was a five-year absolute survival rate of 60.7 per cent. In the 14 "coincident" cases the five-year survival rate was 42.9 per cent. In the entire group of 98 cases, the absolute survival rate was 58.2 per cent; the relative survival rate was 63.3 per cent.

In only 5 of 98 cases was any surgical procedure done, and in 2 of these irradiation was also given. Eighty-one patients were treated by means of combined radium and roentgen therapy, and in the remainder radium or roentgen therapy was used alone. Transvaginal roentgen therapy apparently was not employed. The usual radium treatments were given two or three times weekly with a single 50-mg. tube filtered with 1 mm. of platinum, for a total dosage of 4,000 mg.-hr. Most of the patients treated with roentgen rays received 540 r (air) to each of four pelvic fields following radium treatments, with factors of 50 to 70 cm. distance, 200 kv, half-value layer 1.0 mm. of copper.

Complications are not discussed, but the authors stress the great necessity for combining the highest diagnostic skill on the part of the gynecologist with the most competent radiotherapy in approaching the problem of carcinoma of the cervical stump.

Nine tables; 3 figures. ROBERT L. EGAN, M.D.
University of Texas, Houston

Demographic Studies on Carcinoma of the Uterine Cervix in Sweden. Part I. O. G. A. Berggren. *Acta radiol. (suppl. 145)* pp. 1-147, 1957. (Gynecological Department of the Radiumhemmet, Stockholm, Sweden)

The purpose of the present study is to provide a background for continued investigation of factors that may influence the occurrence of carcinoma of the cervix.

In the clinics where cervical cancer is treated in Sweden, cases have been analyzed with respect to distribution between towns and rural districts. The material has also been analyzed by stages according to the International Classification, and at the same time is broken down into series according to residence in the capital, provincial towns, or rural districts. The possible causes of carcinoma of the uterine cervix are discussed, and the geographic distribution in Sweden is considered at length. The distribution of carcinoma in Sweden and Denmark is found to be similar with relation to occurrence in rural districts, provincial towns, and cities.

The material used for this study was assembled from the entire country, for 1935, 1940, 1945, and 1950, covering altogether 1,822 cases. These particular years were selected because they were census years. Complete data on age distribution by five-year groups, civil status, etc., for the population of the entire country are presented.

The present investigation was thought to justify the following conclusions:

(1) The risk that carcinoma of the uterine cervix will develop is much greater for women residing in town than for those in rural districts in Sweden.

(2) "Classified milder" forms of carcinoma of the uterine cervix comprise a larger proportion of cases in each successive reported year in the material studied. This applies to series from all four clinics represented.

(3) The rural districts present a greater percentage of the "classified more severe" forms of carcinoma of the uterine cervix than do the towns.

(4) The morbidity of carcinoma of the uterine cervix has shifted toward younger age groups during the period covered by the investigation. This is particularly true of the rural population.

(5) The investigation shows that the increase in the incidence of carcinoma of the uterine cervix in the country as a whole may be attributed to the rural district population.

Forty diagrams; 93 tables.

PAUL S. O'BRIEN, M.D.
Bowman Gray School of Medicine

The Management of Wilms' Tumor as Determined by National Survey and Review of the Literature. Benjamin S. Abeshouse. *J. Urol.* 77: 792-813, June 1957. (100 W. Monument St., Baltimore 1, Md.)

This article is a comprehensive discussion of the general subject of Wilms' tumors and their treatment. Data are drawn from previously published material and from a special survey conducted by the author. A comprehensive questionnaire relative to this tumor was sent to 750 members of the American Urological Association and to 54 members of the Section on Surgery of the American Academy of Pediatrics. A total of 126 replies was obtained, 116 from urologists and 10 from pediatric surgeons. Eighty-one surgeons furnished accurate and complete data on 856 cases. The information thus obtained (the questions themselves are not printed here) was utilized in a statistical analysis of the management of Wilms' tumor as currently practiced.

Major conclusions include the following and are based on the survey, on the literature review, and on the author's personal experience with 6 cases. The consensus is that operation may be safely postponed until an accurate diagnosis has been established. Ordinarily, the preoperative diagnostic studies will include, as a minimum, palpation of the tumor and intravenous and retrograde pyelographic studies. Tabulation of the reported treatment methods indicates that 44 per cent of the responding surgeons favored nephrectomy plus postoperative irradiation; 22 per cent preferred preoperative irradiation, nephrectomy, and postoperative irradiation. Among the remainder the choice was scattered among preoperative radiotherapy followed by nephrectomy, nephrectomy alone, and radiotherapy alone.

A study of results in 777 operated cases with adequate follow-up for determination of data showed a low operative mortality (2.7 per cent), a high percentage of patients dying in the first postoperative year (54 per cent), and a relatively small number of two-year survivors. From the material in the literature it appears that preoperative radiotherapy plus nephrectomy plus postoperative radiotherapy will produce a slightly better two-year survival rate than will nephrec-

tomy plus postoperative irradiation only. Best results are obtained when the disease is diagnosed and treated during the first year of life.

Considerable space is given to the role of irradiation in the management of Wilms' tumor. The theories, methods, and dangers of radiotherapy are discussed, obviously from the point of view of the surgeon. The serious danger of radiation nephritis is cited. [The discussion relative to radiotherapy seems amateurish and is typified by the statement, "There has been a decided trend on the part of most surgeons to leave the dosage and duration of irradiation to the discretion of the radiologist." The article is a general one with much statistical data and does not lend itself well to abstraction—J. W. B.]

Six tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Radon Seed Implantation in Carcinoma of the Bladder. Harold J. Ham. *Proc. Coll. Radiologists Australasia* 1: 21-24, June 1957. (Royal Prince Alfred Hospital, Sydney, Australia)

The author reports on 86 cases of carcinoma of the bladder treated by radon seed implantation between 1937 and 1952. Seventeen patients were over seventy years of age and 1 was over eighty years of age. The average age was 61.8 years and males predominated to an extent of 75.6 per cent. The commonest early symptom was painless hematuria, which was encountered in 64 per cent of the cases.

In 1937, the only available radon seeds in Australia had a filtration of 0.3 mm. of gold. More recently 0.5 mm. of gold filtration is used. In earlier years 1.1 millicuries of radon was used for bladder neoplasm, but now seeds containing 0.8 or 0.85 millicuries have been adopted, since these values make uniform distribution of dosage more easily obtainable.

Because of the accuracy essential in radon implantation, the author advises that this be done through a suprapubic cystostomy. After the tumor is exposed, the protuberant portions are removed down to the level of the surrounding mucosa by a diathermy loop. The seeds are then implanted over an area at least 1 cm. wide of the clinically defined edge of the growth, and also into the central area comprising the base of the tumor. A dose of 6,500 r estimated at 0.5 cm. distance is the tumor dose generally adopted. With larger tumors, this may be reduced to 6,000 r, and if induration is present, it is wise to increase the dose to 7,000 r. It is important to implant the outer ring of seeds first and the central seeds last to avoid implanting tumor cells beyond the confines of the tumor.

Ralston Paterson has enumerated the types of growths of the bladder suitable for radon seed implantation (*Brit. J. Radiol.* 14: 219, 1941. *Abst. in Radiology* 38: 638, 1942): (a) noninfiltrating growths in which three-quarters of the bladder is clear; (b) infiltrating growths relatively small in size; (c) large papillary carcinomas with small pedicles; (d) multiple (not more than 3) lesions, if small. Although in most cases a superficial sloughing reaction in the mucosal surface is seen after radon seed implantation, in the majority the bladder is healed in two months. It is generally agreed that no second radical treatment by radon should be attempted in the bladder.

Of the 86 patients treated, 30.2 per cent were alive and free of recurrence after three years or more. Ten died of intercurrent disease, and in 4 of these the

bladder was without evidence of tumor at the time of death. A five-year follow-up on 71 of the 86 cases revealed a survival of 29.5 per cent, with no recurrence noted. The results were better with tumors that were originally less than 4 cm. in diameter. These showed a 50 per cent three-year survival as compared to 17.3 per cent for tumors over 4 cm. in diameter. Lack of induration and intramural extension also was more favorable.

The author concludes that radon seed implantation is the treatment of choice for the majority of carcinomas of relatively small size confined to the bladder.

Four tables.

JOHN F. FOTOPoulos, M.D.
Hartford, Conn.

Carcinoma of the Vulva. John H. Isaacs and Nathan H. Topek. *Am. J. Obst. & Gynec.* 73: 1277-1285, June 1957. (Mercy Hospital Institute of Radiation Therapy, Chicago, Ill.)

Carcinoma of the vulva is a disease of older women, and with the overall increase in life expectancy there has been a concomitant rise in its incidence. From 1939 through 1955 the total number of cases seen in the Mercy Institute of Radiation Therapy and Clinics and Lewis Memorial Maternity Hospital (Chicago) was 41; 43.9 per cent of these were seen after 1950. Prior to 1940 the five-year survival was usually reported to be less than 20 per cent, reflecting the inadequacy of haphazard treatment.

Definitive treatment of carcinoma of the vulva is nothing less than radical surgical excision. Such planned therapy during the past fifteen years has resulted in salvage rates approaching 60 per cent. The absolute contraindications to surgery are lung or long bone metastases. In good operative risks the Way operation is performed. In poorer risk patients, a very adequate radical vulvectomy is of prime importance, to be followed by node dissection when the patient has adjusted to the initial surgical assault. In the last ten years of the survey, when the plan of therapy has been more definite and the patients so treated, the survival rate has been 54.5 per cent of the cases.

In discussing the paper, Dr. Conrad G. Collins (Tulane Unit at Charity Hospital, New Orleans, La.) reviewed 28 consecutive cases of invasive carcinoma of the vulva seen between 1946 and 1951 with a five-year survival rate of 61 per cent. Since 1946 there has been followed a planned rigid protocol for diagnostic criteria and a very definitely prescribed surgical attack. In similar cases seen during the same years and treated less strictly at the Louisiana State University Service there was a survival rate of only 17 per cent.

Six tables.

ROBERT L. EGAN, M.D.
University of Texas, Houston

X-Ray Therapy in the Private Practice of Dermatology. David Goe Welton. *South. M. J.* 50: 648-653, May 1957. (403 N. Tryon St., Charlotte 2, N. C.)

Data concerning the total number of patient-visits and the total number of x-ray treatments given, as well as the condition for which they were administered, accumulated and tabulated over a period of eight months in three separate private practices of dermatology are presented. One office was located in Charlotte, N. C., one in St. Paul, Minn., and the other in Honolulu, Hawaii. The total number of x-ray treatments given was 4,630, in a total of 24,944 patient visits. In the 2

offices located in the continental United States, the three conditions most frequently irradiated were acne, epithelioma, and neurodermatitis. The total number of x-ray treatments given in the office in Hawaii during the eight-month period amounted to only 9 per cent of the combined total for the three offices, and keloids, pustular bacterids, and furuncles were the conditions most frequently irradiated.

This study represents an initial attempt to determine the frequency of the use of superficial x-ray therapy in the private practice of dermatology today. A more comprehensive survey, embracing more dermatologists, representing more geographic areas, and covering a period of a year is planned. This will include a diagnostic tabulation of all patients seen, the number who had had previous irradiation to safe limits, and the average number of x-ray treatments per patient for each condition.

Ten tables.

X-Ray Therapy in Post-Traumatic Arthritis, Para-arthritis and Fasciitis. Basil A. Stoll. M. J. Australia 1: 868-873, June 22, 1957. (Peter MacCallum Clinic, Melbourne, Australia)

The author discusses the usual etiologic and pathologic factors of post-traumatic arthritis, para-arthritis, and fasciitis. He quotes the experience of various writers in the management of these conditions and tabulates the results of treatment in his own patients. In general, x-ray therapy was given in a dosage of from 400 to 1,000 r over a period of one to three weeks.

In post-traumatic arthritis, such radiation therapy resulted in relief of the periarticular swelling and pain on weight-bearing and movement in approximately 50 per cent of cases, even when symptoms dated back nine to twenty-four months. In posttraumatic para-arthritis relief of symptoms occurred within one or two weeks; only 3 of 36 cases failed to respond to radiation therapy. In 10 of 13 cases of post-traumatic fasciitis pain was relieved following x-ray treatments.

The author discusses the theoretical mode of action of radiation in the treatment of these conditions, again reviewing the literature on this subject.

Three tables.

JAMES E. BAUER, M.D.
Victoria, Texas

The Manchester Trunk Bridge for the Treatment of Radiosensitive Tumours. E. C. Easson, J. B. Massey, B. E. Jones, and R. S. Pointon. Brit. J. Radiol. 30: 311-317, June 1957. (Christie Hospital and Holt Radium Institute, Withington, Manchester 20, England)

In treatment of a radiosensitive tumor, irradiation of a large volume of tissue containing the tumor and its regional lymphatics, preferably in one undivided volume of homogeneous dosage, is desirable. The therapy course usually extends over a period of several weeks and, in order to achieve accurate dosage, an easily and reliably reproducible technic is essential. This can be achieved best by the use of a trunk bridge.

The purpose of this paper is to describe this method of large field therapy, to discuss the factors controlling dose distribution, and to describe some of the more recent modifications of the apparatus and their place in clinical practice.

The trunk bridge uses four x-ray beams of equal area. Two anterior beams inclined at an angle of 60° to each other are opposed to two similarly arranged posterior

beams. The interapical distance is variable and determined by the patient's thickness. The distance between the upper edges of the beams and the apex and the angle of inclination are fixed. The same exposure is given by each of the four beams. The resulting isodose distribution shows two sets of substantially flat isodose curves with a slowly falling gradient. The combination of two such parallel opposing internal fields produces the desired large volume of reasonably homogeneous dosage.

All four fields are treated daily. For the dosage prescription, measurements are taken with the bridge in place and the cones as close as possible to the skin. The levels of collars supporting the bridge are measured on graduated posts to obtain data to reproduce the patient's position inside the bridge. The gap between the apex of the bridge and the patient is measured and also the anteroposterior thickness of the patient at the midline and at the center of the long axis of the zone to be treated. The sum of the two gaps and the mean diameter of the patient give the interapical distance, which is the clinical measurement on which the dosage prescription depends. All spaces between the patient and the applicator are filled with bolus material.

In prescribing treatment there are four principal considerations.

1. **Tumor Dose:** Of prime importance is the value of the dose throughout the "homogeneous" central region in which the tumor lies during treatment. The dose at the midpoint of the interapical axis is a satisfactory index of this central dose. The contribution of each applicator assessed with full back-scatter is referred to as the *given dose* (100 per cent) and the combined contribution of the four beams at the center as the *summed percentage depth dose*.

2. **The Treated Width:** The choice of applicator width varies with the width of the anatomic region to be treated.

3. **High Dose Regions:** There are regions of higher dose anteriorly and posteriorly caused by overlapping of the two adjacent beams.

4. **The Treated Length:** This dimension is controlled by the applicator length. Since a large volume of tissue can tolerate only relatively low dosage, the use of the trunk bridge is limited to the treatment of radiosensitive tumors. Since these tumors are also characterized by a tendency to early lymphatic metastasis, the applicator selected should be long enough to irradiate a margin of 5 to 7 cm. above and below the known or suspected malignant lesion.

The trunk bridge is particularly suited to the radical treatment of radiosensitive tumors such as seminoma, testicular and ovarian tumors, reticulosos, and lymphosarcoma.

Modifications of the conventional trunk bridge can be of great value. These include: asymmetrical dose distribution, with wider applicators on one side than on the other; half-trunk bridge for treating one side only through anterior and posterior fields; vertical trunk bridge for treating patients in the erect position; the three-field trunk bridge with a single applicator opposing the two posterior oblique fields.

In place of a trunk bridge, an apical pin may be attached to any conventional x-ray applicator and accomplish the same result. This is more comfortable for the patient and permits easier and more rapid field alignment. With this device, however, there is danger of under- or overdosage in irradiation of an abdomen

which changes size during the therapy course. Its use is best limited, therefore, to the thorax, head, and neck. Five photographs; 9 diagrams; 1 table.

RICHARD P. STORRS, M.D.
Los Angeles, Calif.

The Design of Wedge Filters for Use with a 4-MeV Linear Accelerator. F. W. Tranter. *Brit. J. Radiol.* 30: 329-330, June 1957. (Christie Hospital and Holt Radium Institute, Withington, Manchester 20, England)

Wedge filters have been used for many years in radiation therapy where the choice of entrance portal for multiple fields is limited to a small region of the patient's skin, or where a long entrance path may be avoided by using them. With 4-MeV therapy these restrictions are less important but the oblique incidence at this energy brings new problems which may be solved by using wedges.

Several wedge filters made of aluminum are in use with the 4-MeV accelerator at Manchester. The procedure for designing these wedges is given in some detail. They offer the following advantages:

(a) The isodose curves retain their slope over the width of the field down to appreciable depths. (b) The "hot spot" is usually not very high. (c) The same filter may be used regardless of the dimensions of the unwedged axis and for various dimensions of the wedged axis smaller than that for which the wedge was designed. (d) The output is not drastically reduced by the wedge filter.

With the wedge filter, it has been found convenient to use the isodose curve calculation described earlier by the author with certain modifications outlined in the present paper. (Tranter: *Brit. J. Radiol.* 29: 92, 1956. *Abstr. in Radiology* 67: 921, 1956).

Two figures. RICHARD P. STORRS, M.D.
Los Angeles, Calif.

RADIOISOTOPES

Diagnostic and Therapeutic Applications of Radioactive Iodine in Thyroid Diseases. J. M. Cerviño, Julio Morató Manaro, Jorge Maggiolo, and E. Zaldúa de Delfino. *Radiologia, Panama* 7: 95-110, June 1957. (In Spanish) (Instituto de Endocrinología, Ministerio de Salud Pública, Montevideo, Uruguay)

In their diagnostic studies with I^{131} , the authors used both the indirect method, based on urinary excretion of the isotope at twenty-four and forty-eight hours following administration, and the direct twenty-four-hour uptake test with a scintillation counter. They believe that in only 20 per cent of cases is it necessary to supplement I^{131} tests by other studies. They state that the use of the test combined with the basal metabolism determination involves an error of only 6 per cent.

Indications for the therapeutic use of I^{131} in thyroid disease are enumerated as follows: (1) diffuse goiter with hyperthyroidism in patients over forty-five; (2) recurrent hyperthyroidism after surgery, especially when there is paralysis of the vocal cord [no explanation]; (3) cases which are inoperable for such reasons as cardiac failure; (4) hyperthyroidism without goiter in patients over forty-five; (5) goiters with severe exophthalmos. I^{131} is contraindicated in children and young adults because of the possibility of a carcinogenic effect; in pregnancy because the isotope passes beyond the placenta and may be fixed by the fetal thyroid; during lactation because of excretion in the milk. Less absolute contraindications are the toxic single nodular goiter and the multinodular goiter with hyperthyroidism.

The authors treated 56 patients with I^{131} , of whom 49 were observed over a protracted period. Of these, 79.6 per cent had diffuse goiters. Of the 49, 47 recovered. Among this latter number were 38 who received a single dose of 4 to 14 millicuries, representing an average of 150 to 200 microcuries per gram of thyroid tissue. Nine patients received two doses, totaling 14 to 20 millicuries. In 2 patients no improvement occurred. In each of these the hyperthyroidism was associated with diabetes. In 28 (61 per cent) of 46 patients with goiter, the goiter disappeared, it was greatly reduced in 12 cases (26 per cent), and showed little or no alteration in 6 (13 per cent).

The following complications were observed: (1) ag-

gravation of hyperthyroidism in 17 cases; (2) "insufficiency of the thyroid gland" in 7 cases, transitory in 3 and persistent in 4; (3) aggravation of latent hypoparathyroidism in 1 case; (4) jaundice of the "hepatic" type, 1 case.

Six tables. L. ALFONSO VARELA, M.D.
St. Vincent's Hospital, New York

Correlation of Early Extrathyroidal Radioiodide Space with Body Weight. Rosalyn S. Yalow, Estelle S. Sobel, and Karl R. Paley. *J. Clin. Endocrinol.* 17: 424-433, March 1957. (Isotope Laboratory, Lenox Hill Hospital, New York, N. Y.)

The authors determined the mean radioiodide spaces of distribution during the first half hour following intravenous administration of I^{131} in euthyroid subjects in the normal weight range, using Berson's method (*J. Clin. Investigation* 31: 141, 1952) and compared their results with his. Also, the mean spaces for grossly overweight and underweight subjects and for hyperthyroid subjects within the normal weight range were determined.

Thirty-one euthyroid, 8 hyperthyroid, and 1 hypothyroid subjects were included in this study. Eleven subjects were outside the normal weight range. A tracer dose of 25 to 58 microcuries of I^{131} was administered intravenously, following which the radioactivity over the neck region was assayed at one-minute intervals for thirty minutes. During this period several venous blood samples were drawn. The half-hour urinary excretion represented less than 10 per cent of the radioactivity, which is negligible.

For both males and females in the normal weight range, the half-hour space of dilution of I^{131} was found to be 20 ± 2 per cent of the body weight, which differs from Berson's finding by less than 2 per cent. For all subjects outside the normal weight range, the mean half-hour space is better correlated with the average weight for the subject's height and age than with the actual weight. The gain or loss of weight in the body compartment accounts for only a negligible amount of rapidly equilibrating iodide in calculation of the I^{131} space. The authors feel that an indirect determination of the mean plasma concentration from the body weight value is not likely to reduce the reliability of the thy-

roidal iodide clearance test as an index of thyroid function and would not introduce an error large enough to cause overlapping between euthyroid and hyperthyroid clearance values.

Four figures; 4 tables. WANG YEN, M.D.
Mercy Hospital, Pittsburgh, Penna.

The Effect of Phenylbutazone and a Related Analogue (G-25671) upon Thyroid Function. Joseph A. Link, Bruce C. Paton, Murray Persky, Marion Isaacs, and Herbert S. Kupperman. *J. Clin. Endocrinol.* 17: 416-423, March 1957. (J. A. L., 4021 Atlantic Ave., Atlantic City, N. J.)

Phenylbutazone is a drug which has been shown to have effects similar to those of cortisone and corticotropin with respect to antirheumatic activity and sodium retention. In 1952, it was demonstrated that it also had a marked inhibiting action on the uptake of I^{131} by the thyroid (Green, *et al.*: *Proc. Soc. Exper. Biol. & Med.* 82: 155, 1953) in rats. The present study was designed to confirm the previous findings in man.

Thirteen euthyroid patients were used for the study. In all 13, a control twenty-four-hour thyroidal uptake after oral administration of I^{131} was determined at least one week prior to administration of phenylbutazone and G-25671. Phenylbutazone was administered orally in a daily dose of 800 mg. for four days. On the morning of the fourth day, at least one hour before breakfast, the I^{131} was given. Twenty-four hours later the counts were made and, at the same time, a blood sample was taken for estimation of the plasma level of the phenylbutazone. This procedure was repeated in 4 patients using G-25671 instead of phenylbutazone.

The acute effect of phenylbutazone was also studied in 3 patients after intravenous administration of the drug. The rate of thyroidal I^{131} uptake was first determined over a ten-hour period. At a later date the same patients were given simultaneously 800 mg. of phenylbutazone intravenously and a dose of I^{131} orally. The rate of thyroidal I^{131} uptake was then redetermined at one, two, and ten hour intervals.

With administration of phenylbutazone, a consistent and marked reduction in thyroidal uptake of I^{131} was seen in all 13 patients. G-25671 did not interfere with I^{131} uptake. It was found that phenylbutazone and cortisone, in addition to their known parallel effects of antirheumatic, ulcerogenic, and uricosuric activity, depress the thyroidal uptake of I^{131} and in both instances this depression is apparently neutralized by the administration of TSH. The effect of phenylbutazone is temporary, despite continued therapy, whereas that of cortisone is maintained as long as the drug is administered. Within the limits of the studies reported in this article, the depression of pituitary function is the most likely explanation for the lowering of the thyroidal I^{131} uptake by phenylbutazone.

Five figures; 1 table. W. CADMAN CHAFFIN, M.D.
Mercy Hospital, Pittsburgh, Penna.

The Exchangeable Character of Accumulated I^{131} in the Thyroid Gland of a Goitrous Cretin. Alvin L. Schultz, Edmund B. Flink, Byrl J. Kennedy, and Leslie Zieve. *J. Clin. Endocrinol.* 17: 441-444, March 1957. (VA Hospital, Minneapolis, Minn.)

A 34-year-old white male had been recognized as a cretin shortly after birth. When first seen by the authors, he gave a history of thyroid enlargement for the

past fifteen years. This was associated with dysphagia and dyspnea for the past three years. A goiter, removed by thyroidectomy, weighed 647 grams and manifested adenomatous, cystic, and degenerative changes.

Thyroid function studies prior to surgery showed an I^{131} uptake of 22 per cent at twenty-four hours. Following an oral dose of 300 microcuries of I^{131} , the thyroidal I^{131} rapidly increased to 33 per cent at the end of three hours. It remained at this level for the next three hours. At this time a dose of 2 grams of thiocyanate was given orally after the second I^{131} tracer, producing immediate decrease in thyroidal I^{131} . Thirty minutes afterward, half of the accumulated I^{131} had been discharged. There was no further decrease half an hour later. Meanwhile, the plasma total I^{131} content had doubled, but there was no increase or change in the plasma protein-bound I^{131} .

These findings in regard to the behavior of thyroidal I^{131} substantiate the report by Stanbury and Hedge (*J. Clin. Endocrinol.* 10: 1471, 1950) that, although thyroid hormone cannot be synthesized by the thyroid gland of a goitrous cretin, the thyroid glands of these patients have a supernormal avidity for I^{131} and that the accumulated thyroidal I^{131} can be readily discharged with the administration of thiocyanate, indicating that the trapped isotope remains in the form of iodide and is diffusible. This points to a defect in the conversion of iodide into an organically bound form and the resulting large goiters are the result of compensatory hyperplasia. This is important, since the dissociation of the process of iodide trapping and hormonal synthesis in goitrous cretins supports the concept of the existence of separate mechanisms for these functions in the normal thyroid gland.

One photograph; 1 graph.

H. RODRIGUEZ DELGADO, M.D.
Mercy Hospital, Pittsburgh, Penna.

The Use of Radioiodine in the Cardiac Patient. Harry T. Harper, Jr., Stephen W. Brown, and Irene F. LaMotte. *South. M. J.* 50: 612-614, May 1957. (Medical College of Georgia, Augusta, Ga.)

The authors make a plea for the administration of I^{131} in patients with myocardial insufficiency when they no longer respond to bed rest, digitalis, and diuretics. While this treatment should not be instituted as long as there is a response to conventional therapy, one must seize the optimal time, before the patient is moribund. The dosage should be adequate. The authors believe it is better to err on the side of overdosage, with control of resulting myxedema by appropriate administration of thyroid substance, than it is to give too little and to have to repeat treatment at intervals. The poorest results were obtained in the patients who received "too little too late."

Excellent results were obtained with I^{131} in 17 of 29 patients with refractory angina pectoris, good results in 8, and poor results in the remainder. In 55 cases of refractory congestive failure, excellent results were obtained in 23, good results in 13, and poor results in the remainder. Although a high percentage of patients with excellent results eventually died, their lives were made much more livable and the therapy was considered worthwhile. It is felt that treatment with I^{131} is as effective as any surgical procedure reported to date and is without mortality.

Two tables.

Biliary Excretion and Metabolism of Radioactive L-Triiodothyronine. Eunice V. Flock, Jesse L. Bollman, and John H. Grindlay. *Am. J. Physiol.* **189**: 420-424, June 1957. (Mayo Clinic Foundation, Rochester, Minn.)

The authors studied the I^{131} distribution in urine and bile after administration of I^{131} -labeled L-triiodothyronine to normal dogs and subsequently to the same animals with first a biliary fistula and later biliary obstruction.

Dogs with biliary fistulas metabolized triiodothyronine rapidly to inorganic iodide, as did normal dogs. The amount and distribution of I^{131} compounds in the urine were not greatly altered by withdrawal of the bile, which contained one-fourth of the I^{131} administered. Dogs with biliary obstruction excreted more of several I^{131} compounds than normal dogs. The absence of enterohepatic circulation of metabolic products of triiodothyronine usually excreted in the bile did not appreciably alter the products or rate of metabolism of triiodothyronine. Some of the same products of triiodothyronine appeared in both bile and urine, but there was very little inorganic iodide in the bile and much more of the glucuronide and the water-soluble, column residual fraction.

Six figures; 2 tables.

Role of Pituitary, Adrenal and Kidney in Several Thyroid Responses of Cold-Exposed Hamsters. Karl M. Knigge, Robert S. Goodman, and David H. Solomon. *Am. J. Physiol.* **189**: 415-419, June 1957. (School of Medicine, University of California at Los Angeles, Los Angeles, Calif.)

The role of the pituitary, adrenal, and kidney was investigated in several of the thyroid responses of hamsters to acute and chronic cold exposure. The pituitary body was found to be necessary for (1) maintenance of normal thyroid weight, histology, and I^{131} uptake in hamsters housed at room temperature; (2) survival of cold-exposed hamsters; (3) the increased thyroid I^{131} uptake occurring during cold exposure.

Initially cold exposure evokes a brief period of accelerated release of thyroïdal I^{131} followed by complete inhibition of release. Also during the period of initial cold exposure, I^{131} uptake is sharply depressed, probably because of an increase in renal elimination of iodide. This renal mechanism is independent of the adrenal glands but appears to require the presence of the pituitary.

One chart; 2 tables.

Radioactive Iodinated Human Serum Albumin in the Diagnosis of Intracranial Mass Lesions. E. S. Gurdjian, J. E. Webster, H. R. Lissner, W. G. Hardy, and D. W. Lindner. *Neurology* **7**: 392-398, June 1957. (E. S. G., 1553 Woodward Ave., Detroit 26, Mich.)

Radioactive iodinated human serum albumin was used by the authors for a period of eighteen months (September 1954-April 1956) as an aid in localizing brain tumors in 116 patients (120 surveys). Their method of performing the surveys is described. The results can be divided into the following four groups:

Group I: Twenty-seven of 49 tumors were correctly localized by the isotope studies, with confirmation by operation or autopsy. The tumors included 13 glioblastomas, 10 astrocytomas, 1 meningioma, 1 metastatic tumor, 1 pinealoma, 1 medulloblastoma.

Twenty-five of 39 hemispheric lesions were correctly

diagnosed (64 per cent). Only 2 of 7 posterior fossa tumors were correctly diagnosed. Three tumors above the optic area and at the base of the frontal lobes were completely missed.

Group II: Twenty-two tumors were not detected by the survey, but their presence was established by air studies, angiography and/or operation. In this group were 6 glioblastomas, 3 astrocytomas, 2 oligodendrogliomas, 4 meningiomas, 3 cerebellopontine angle tumors, 1 primary neoplasm of the optic chiasm, 1 chromophobe adenoma of the pituitary, and 2 metastatic tumors.

Group III: There were 7 cases in which a definite increase in the amount of radioactive uptake was obtained, but the presence of a tumor was not corroborated by air studies. In 1 patient, with a significant increase in radioactive uptake in the occipital area, there was a tumor in the frontal region on the same side. It was thought that the remaining 6 patients did not have brain tumors or any other mass lesions.

Group IV: This group included 64 negative results. Differences in count rate from right to left were 150 or less, which has been found to be insignificant for localization of brain tumors. There were 25 cases of vascular disease of the nervous system.

The authors consider their experience with radioactive iodinated human serum albumin disappointing, and this agrees with the reports of others. They believe, however, that such studies should be continued with other radioactive substances with a view to obtaining a clinically useful test. Although P^{32} is excellent for direct counting in the operating room, a comparable substance for preoperative surveys has not yet been found.

With the early use of a simple test in the course of a progressive disease, negative findings may be expected. Repeated examinations may later locate the lesion accurately.

Two tables.

The Clinical Use of Radioisotopes in the Differential Diagnosis of Anemia. William L. Hughes, Philip C. Johnson, E. Stanley Berger, and Robert M. Bird. *South. M. J.* **50**: 709-712, June 1957. (Oklahoma School of Medicine, Oklahoma City, Okla.)

Co^{59} -labeled vitamin B_{12} can be given orally and its absorption from the gastrointestinal tract measured. The basic defect in pernicious anemia is thought to be a permanent deficiency of gastric intrinsic factor so that adequate absorption of vitamin B_{12} fails to occur. Since this defect is not influenced by parenterally administered vitamin B_{12} , the demonstration of faulty absorption establishes the diagnosis of pernicious anemia despite prior treatment. Three cases are presented to illustrate the value of this test. In the first case the clear-cut difference between the absorption of vitamin B_{12} given alone and with normal gastric juice made it possible to establish a diagnosis of pernicious anemia despite the long administration of the vitamin intramuscularly. In the second instance the prior administration of hematinics, while failing to correct the hematologic and neurologic findings, made it impossible to establish an accurate diagnosis by examination of the blood or bone marrow. Co^{59} -labeled vitamin B_{12} excretion studies established the diagnosis of pernicious anemia. In the third case Co^{59} -labeled vitamin B_{12} studies permitted a differentiation between pernicious anemia and so-called nutritional macrocytic anemia.

Erythrocytes may be labeled with chromium 51 and

reinjected into the donor. One may then conveniently measure the rate of disappearance of radioactivity from the circulation. From these data the rate of hemolysis can be estimated. Three cases illustrate the usefulness of this technic in the diagnosis of hemolytic anemias.

Limitations of Radioisotope Therapy for Prostatic Carcinoma. Frank Hinman, Jr., and Glenn E. Sheline. *J. Urol.* **77**: 871-874, June 1957. (University of California School of Medicine, San Francisco, Calif.)

The authors review reported clinical results in the treatment of nonmetastatic carcinoma of the prostate by radioactive gold and chromic phosphate with an attempt to answer the question: What is the place of isotope therapy in this disease?

Patients chosen for radioisotope therapy are usually those in whom the tumor has spread outside the capsule but is still confined to the immediate area of the gland, without evidence of distant metastatic disease. Evidence now indicates there is little or no hope for complete sterilization of the tumor by presently used methods of isotope application. Such factors as inability to obtain homogeneous irradiation or favorable irradiation patterns and relative inaccessibility of some parts of the tumor spread are important factors in this conclusion. It appears it is practically impossible to sterilize any except the very smallest neoplasms by radioactive material alone. Clinical results in adequately followed series are not favorable when compared with the more conventional methods of surgery, castration, and estrogen therapy.

The efficacy of the isotopes in palliation or arrest of prostatic carcinoma is also considered. Rather severe reactions to the implantations, including local edema, rectal complications, and intractable pain, are to be reckoned with. There seems to be considerable doubt that patients are really better off as a result of the isotope therapy, even after these complications have been controlled. There is also the admitted fact that radio-colloids have no effect on distant disease, which may be favorably influenced by other methods.

Conclusions are that the results so far available do not justify the use of radioactive substances in the routine management of nonmetastatic, late prostatic carcinoma. It is felt that further investigation in this direction is indicated, but that, in the meantime, the vast majority of patients will have an easier course if managed by conventional methods.

One table.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Radioactive Calcium Tracer Studies in Bone Grafts. Jonathan Cohen, Constantine J. Maletskos, John H. Marshall, and James B. Williams. *J. Bone & Joint Surg.* **39-A**: 561-577, June 1957. (J. C., 300 Longwood Ave., Boston 15, Mass.)

The present study was undertaken in order to determine what information radioactive calcium (Ca^{45}) tracer technics could add as to the behavior of bone grafts.

In particular, the authors tried to determine what happens to calcium in and around the graft area. Does calcium diffuse into adjacent bone or contribute to nearby callus formation, or is the grafted calcium removed by the circulating blood as the graft area undergoes repair? Does the calcium supply to the graft area come from adjacent bone, or does it come from the circulating blood?

In order to answer the first question, the authors implanted homogeneous bone grafts containing Ca^{45} into dogs. In order to answer the second question they implanted nonradioactive homogeneous bone grafts into dogs which had been injected with Ca^{45} . Samples of blood were taken at intervals up to the time of sacrifice and were analyzed for specific activity.

When the dogs were sacrificed, sections of the graft, the callus, and nearby bone were analyzed for stable calcium (Ca^{40}) and for radioactive calcium (Ca^{45}). A procedure for quantitative autoradiography was developed and applied to the analysis of cross sections of grafted and nongrafted areas.

In this experiment it was found that the distribution of Ca^{45} from radioactive grafts was systemic; no preferential transfer of Ca^{45} to callus or nearby bone was detected.

In the dogs which received nonradioactive grafts and injection of Ca^{45} , the specific activity of the callus was the highest observed anywhere in bone, up to one hundred times that of cortical bone, and it was strongly dependent upon the relation between the time of injection and the time of grafting.

In this experiment, relocation of localized deposits of activity without dilution in the whole volume of circulating blood (hot-spot migration) to or from graft areas was not detected.

Nine figures; 2 tables. J. P. CHAMPION, M.D.
Grand Rapids, Mich.

Comparative Estimation of Blood Volume by P^{32} Tagged Red Cells and Dye Haematocrit Method in Human Subjects. B. Basu, K. L. Bhattacharjee, and A. Bose. *J. Indian M. A.* **28**: 469-472, June 1, 1957. (Chittaranjan Cancer Hospital, Calcutta, India)

Simultaneous estimation of blood volume was carried out in 38 females, with P^{32} -tagged cells and Evans blue dye (T-1824). The mean volume obtained by the P^{32} -labeled cell method was 60.2 ± 9.21 ml./kg. and by the dye-hematocrit method 82.1 ± 11.3 . The mean ratio of the volume obtained by the two technics was 0.75 ± 0.056 .

The authors conclude that total-cell volume may be determined correctly by the tagged-cell method. A comparatively more accurate total blood volume might be achieved, however, by estimating the cell volume by the tagged-cell method and the plasma volume by the dye-hematocrit method.

Two tables.

Cerebral Changes Revealed by Radioautography with S^{35} -Labeled L-Methionine. Stevenson Flanigan, Elmer R. Gabrieli, and Paul D. MacLean. *Arch. Neurol. & Psychiat.* **77**: 588-594, June 1957. (Yale University School of Medicine, New Haven, Conn.)

A radioautographic study was undertaken to ascertain the fate of radiosulfur in the brain of rats to which S^{35} -labeled L-methionine had been administered intraperitoneally under a variety of experimental conditions. A comparison was made between the cerebral radioautograms of controls and those of animals that had received, respectively, colloidal thorium dioxide (Thorotrast), whole-body x-irradiation, infection, convulsive insulin therapy, diallylbarbituric acid (Dial), and reserpine.

Under normal conditions the cerebral radioautograms showed depths of contrast that gave them a striking resemblance to Nissl-stained sections. The degree of intensity of radioactivity paralleled the intensity of

staining seen in Nissl preparations. Following whole-body irradiation (300 r), there was no detectable change between the brains of control and those of experimental animals. Thorotrast produced a slight generalized increase in radioactivity. With infection, reserpine, and diallylbarbituric acid anesthesia, there was a generalized decrease. This change was suggestively greater in structures normally showing high radioactivity. Following insulin-induced convulsions there was also a generalized decrease in radioactivity, and in 1 instance differential changes were clearly discernible in the hippocampus. In these latter experiments, radioautograms brought into striking contrast parts of the brain that appeared chromophobic, or questionably chromophobic, in Nissl-stained sections.

Three figures.

Evaluation of Tritium Cholesterol as a Tracer in Man. Harold Werbin, Delbert M. Bergenstal, R. Gordon Gould, and George V. LeRoy. *J. Clin. Endocrinol.* 17: 337-345, March 1957. (G. V. LeRoy, Argonne Cancer Research Hospital, The University of Chicago, Chicago 37, Ill.)

The authors wished to establish that the tritium in tritium-cholesterol (cholesterol-t) is not labile in the course of catabolism of the sterol in the body to bile acids and steroids, and that tritium derived from the degradation of the side chain does not re-enter (to any great extent) newly synthesized cholesterol or steroid hormones.

By chemical degradative procedures the distribution of tritium between the side chain and the tetracyclic rings was established. A mixture of carbon-14 and cholesterol-t of known specific activities was given intravenously to a human subject. Plasma-free cholesterol and five urinary steroids were isolated, and the ratio of tritium to carbon-14 specific activities determined by means of a liquid scintillation counter.

The data showed that the urinary steroids THE, THF, 11-ketoetiocholanolone, androsterone, and etiocholanolone are derived in part from the intact tetracyclic rings of preformed plasma-free cholesterol, and that the side chain of cholesterol does not appear to be utilized for steroidogenesis. The distribution of tritium in cholesterol-t, as determined by several degradative procedures, shows about 53 per cent attached to the tetracyclic nucleus and the remainder to the side chain.

The findings demonstrate that tritium cholesterol is sufficiently stable to be useful for tracer studies of various aspects of cholesterol metabolism in man.

Three tables; 2 charts.

JAMES A. BURWELL, M.D.
Mercy Hospital, Pittsburgh, Penna.

Studies on the Distribution of Tritium-Labelled Dihydrostreptomycin and Tetracycline in the Body. Torsén André. *Acta radiol. (suppl. 142)* pp. 1-89, 1956. (Farmakologiska Avdelningen, Kungl. Veterinärhögskolan, Stockholm, Sweden)

The writer prepared tritium-labeled dihydrostreptomycin and tetracycline synthetically and, with the use of autoradiographic methods, studied their distribution in the body. Tritium, by virtue of its soft radiation, affords possibilities of localization at cellular level. The production of autoradiograms from complete sections of mice enabled detailed comparisons to be made

directly between the concentrations of antibiotics in various tissues.

In addition to determination of the relative concentrations of dihydrostreptomycin and tetracycline in different tissues, the penetration of those substances into pathologically changed tissue and their distribution volume in the body were investigated. The investigation also afforded an opportunity for observation of the modes of excretion of the relevant antibiotics. Lastly, it was possible, with the aid of radioactivity determinations, to study their stability in the body.

The antibiotics were injected into the tail vein of the mouse by means of a micrometer syringe, and the animals were killed at intervals by immersion in carbon dioxide snow and acetone. Initial surveys were performed by sectioning the frozen animals with a sleigh microtome. For autoradiographs, the animals were killed by decapitation and specimens were taken from specific organs and immediately immersed in isopentane that had been cooled in liquid air. A complete description of the author's techniques are included. Ilford G.5 and Kodak NTB were the films selected for use. Fixing, staining, and mounting are discussed. Geiger-Müller measurements of specimens were also made.

Gross distribution, excretion, and microscopic distribution of the antibiotics under investigation are discussed, and the experimental findings are broken down according to organ systems.

Dihydrostreptomycin was found in high concentration in the blood. It also accumulated in tissues of mesenchymal origin. The concentration of tetracycline, on the other hand, was lower in the blood than in any tissues with the exception of the central nervous system. It was high in lymphoid tissues and in the skeleton. As a sign of excretion, each of the two antibiotics was observed in high concentration in the kidneys, and tetracycline in the liver as well.

After about five hours the greater part of each antibiotic had disappeared from the body tissues; the autoradiographic picture was dominated by activity in the intestines.

The disappearance rate of dihydrostreptomycin and tetracycline from the blood was studied in cats whose renal vessels and common bile ducts had been ligated to prevent excretion. The blood concentration curves showed that for each antibiotic the absorption from the blood had largely terminated twenty to thirty minutes after the injection. In these animals the distribution volume in the body was about three times greater for tetracycline than for dihydrostreptomycin. It is questioned whether any reliable figures can be given at all for the relevant distribution volumes.

Distributions about abscesses created by intermuscular injections of pure cultures of *Corynebacterium pyogenes* and *Mycobacterium tuberculosis bovis* are described.

The presence of tritium-labeled dihydrostreptomycin and tetracycline in urine from mice treated with those antibiotics was studied by means of paper chromatography. The urine, it was found, did not contain other radioactive substances than the relevant antibiotics. On the basis of this observation, it is assumed that the antibiotics were not broken down to any appreciable degree in the body during the five hours covered by the experiment.

Forty-one figures; 1 table.

JOSEPH E. WHITLEY, M.D.
Bowman Gray School of Medicine

RADIATION EFFECTS

Useful Precautions in Radiography from the Genetic Point of View. Israel E. Kirsh. *J.A.M.A.* 164: 553-554, June 1, 1957. (603 N. Cuyler Ave., Oak Park, Ill.)

In June 1956 both the British Medical Research Council on Nuclear and Allied Radiation and the National Research Council of the American National Academy of Sciences revealed findings relative to exposure tolerances that were of interest to physicians in general and to radiologists in particular.

The Genetics Committee of the American organization advised that individuals up to the age of thirty years receive a total accumulated dose to the reproductive cells of not more than 50 r and that not more than an additional 50 r be given to individuals up to forty years of age. For the population as a whole, the average exposure of the reproductive cells to radiation (above the natural background) should be limited up to the age of thirty years to 10 r. Similar conclusions were reached by the British.

Since alterable radiation falls largely in the category of diagnostic studies and the treatment of benign conditions, the British group urge a reappraisal of the indications for these procedures with the hope of curtailing the incidence of leukemia following such practices as whole-body radiation in diagnosis and radiation therapy of rheumatoid spondylitis.

Two simple steps for decreasing the amount of radiation reaching the genitals are the use of lead shields over the reproductive organs, particularly in males, and use of adequate filtration. An easily malleable lead sheet, 1.5 mm. thick, placed over the genitals cuts the exposure during the examination to zero, without interfering with the diagnostic quality of most studies. The use of 2 mm. added Al filter to the usual radiographic equipment and 3 mm. Al to the fluoroscopic machine decreases the amount of undesirable radiation considerably. The use of cones can also be most effective in reducing the radiation to the genitals to insignificant amounts. A small cone used in photofluorography, where the exposure has been high, will reduce the dose to the scrotum to zero.

SAUL SCHEFF, M.D.
Boston, Mass.

Gonad Radiation Dose from Diagnostic Procedures. G. M. Ardran and H. E. Crooks. *Brit. J. Radiol.* 30: 295-297, June 1957. (Medical Division, A.E.R.E., Harwell, England)

The authors report studies directed toward evaluation of the amount of radiation received by the gonads during various diagnostic procedures. They emphasize the difficulties connected with measuring radiation doses ranging from thousands of milliroentgens to fractions of milliroentgens. Their observations are presented in tabular form. In the first table the radiation doses received by the skin and gonads in various examinations are presented. In the second table the effect of filtration on depth dose is evaluated, and in the third table the reduction in male gonad dose when 3 mm. filtration is used is discussed. In addition, the amounts of radiation for testes uncovered and covered with 1 mm. lead sheet are given. The authors emphasize the effect of reducing leakage radiation and scatter.

Three tables.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Maternal and Foetal Radiation Dosage During Obstetric Radiographic Examinations. D. K. Bewley, J. W. Laws, and C. J. Myddleton. *Brit. J. Radiol.* 30: 286-290, June 1957. (Hammersmith Hospital, London, W. 12, England)

The amount of radiation received by the mother and fetus during certain obstetric radiographic procedures using a high-kilovoltage technic (100 to 120 kvp) was determined, and a comparison was made with conventional low-kilovoltage technics (80 to 85 kvp). The authors used tissue-equivalent models having the shape of the maternal abdomen and, after making comprehensive depth dose measurements, came to the conclusion that the inlet view contributed two-thirds of the total dose delivered in a three-film pelvimetry. Also, this projection contributed the greatest dose to the fetal gonads. The lateral view delivered a large skin dose, but the irradiated field was small and included only part of the fetus. The authors agree with Kemp (see *Acta radiol. suppl.* 116, 1954, p. 570) that with higher-voltage radiography the films show lower contrast than those taken with the more conventional low kvp technics. However, the outlines of the important bony and soft-tissue structures are shown satisfactorily.

The following conclusions and recommendations are offered:

"1. We find that the use of a high kilovoltage technique (100 to 120 kVp) results in lower maternal and foetal doses than the more usual low kilovoltage techniques (80 to 85 kVp), other factors being kept constant. The skin dose is reduced to one-half and the improvement persists to all depths.

"2. High kilovoltage screens and fast films should be used. We find that in each case the doses are reduced to half of those needed when using the standard article.

"3. The inlet projection delivers by far the largest doses and should be used only when considered absolutely essential.

"4. It is essential that repeat exposures be kept to a minimum and that the smallest practicable cone should be used. For this reason we suggest that obstetric radiography should be carried out only by experienced radiographers.

"5. In order to keep a check on radiation delivered to individual patients, a record should be kept of all exposures made as well as all films taken."

Four illustrations; 1 table.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Radiation Doses to the Foetal and Maternal Gonads in Obstetric Radiography During Late Pregnancy. C. G. Clayton, F. T. Farmer, and C. K. Warrick. *Brit. J. Radiol.* 30: 291-294, June 1957. (Royal Victoria Infirmary, Newcastle upon Tyne, England)

By means of a water phantom, the authors made measurements of the doses delivered to points corresponding to the maternal and fetal gonads and the center of the fetus in patients of average thickness in late pregnancy, in each of the standard radiographic projections. They felt that the dose to the center of the fetus might be of importance in any attempt at correlation of radiation dose during late pregnancy with the incidence of malignant disease and leukemia in childhood.

It was established that the largest dose to the fetal gonads is received in Thoms' view, and the authors believe that this position should not be used in pelvimetry performed during pregnancy. Their technique called for low kilovoltage, a relatively short F.F.D. (36 in.), and an additional filtration of 1 mm. aluminum. They emphasize that in all obstetrical patients in their department attention is constantly directed to taking a minimum of films and using the smallest possible cones. Seven drawings; 1 table.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Problems of Radiation Protection in the Use of So-Called Conditionally Closed Radioactive Preparations. Hans v. Braunbehrens, Erich Bunde, and Rudolf Witzenzellner. *Strahlentherapie* 103: 112-114, May 1957. (In German) (Institut für physikalische Therapie und Röntgenologie der Universität, Munich, Germany)

The purpose of this short article is to point out the often unheeded danger in handling so-called closed radioactive carriers. Alarmed by a visible break in a gold-plated cobalt pearl, the authors critically examined all their other cobalt pearls which were in use. More than half of them created radioactivity when placed in a solution of hydrochloric acid and alcohol for four days.

The conclusion is reached that not only radium needles and tubes but also radioactive sources should be routinely checked for leakage.

Four photographs.

HERBERT C. POLLACK, M.D.
Chicago, Ill.

Contributions to Survival Made by Body Cells of Genetically Differentiated Strains of Mice Following X-Irradiations. Janice Stadler and John W. Gowen. *Biol. Bull.* 112: 400-421, June 1957. (Department of Genetics, Iowa State College, Ames, Iowa)

The influence of x-irradiation absorbed in three body regions (head, mid, and rear) and in the combination of these regions was measured by three subsequent responses: length of survival, natural resistance to disease, and ability to acquire resistance following contact with the disease agent, *S. typhimurium*. Five genetically differentiated strains of mice (S, Z, K, Q, and Ba) were used, four levels of radiation (0 r, 320 r, 480 r, and 640 r), 8 treatment groups, and both sexes. All mice were 46 ± 3 days of age when irradiated from a 250 kvp x-ray source operated at 30 ma with 0.25 mm. Cu plus 1 mm. Al filter at a dose rate averaging 170 r/min.

The sexes responded in like manner to x-irradiation. A penetration or wave-length effect was indicated in these data. The reactions of the mice to the whole-body irradiation at 250 kvp, 0.25 mm. Cu plus 1 mm. Al filter, 600 r, were similar to those for 100 kvp, Coolidge tube, no filtration, 960 r.

Within the x-ray dose range used the responses of the strains to irradiation were shown to be partially genetically determined.

Shielding of one-third of the body protected the mice of the five strains from 320 r and 480 r, and to much lesser degree, depending upon regional exposures, from 640 r. The dose of 640 r was not of sufficient intensity to allow full expression of strain differences for the different regional exposures.

Whole-body exposure to 320 r reduced the fifteen-day survival for the more sensitive strains Ba and K; 480 r decreased survival in all five strains; the effect of 640 r

was severe enough to largely overcome the genetic differences between the strains.

The mid region of the mouse was most sensitive of the three single regions, and more sensitive than the combined head and rear regions.

Lead shielding, 1/8-inch in thickness, was adequate to protect the given regions from radiation. Three groups completely shielded when exposed to the three dosages of x-rays did not quite duplicate the 0 r group in their reactions. Mortality appeared unrelated to the x-ray dose as 100 per cent survived 640 r, 98.4 per cent 480 r, and 99.6 per cent 320 r.

The strains exhibited their own characteristic responses to different x-ray doses, as was evidenced by the large values for dosage \times strain interactions. These interactions were real, representing the expressions of genetic resistance and as such would contribute to the strain effects.

Mortality from whole-body irradiation was only partially accounted for by the combined mortalities resulting from the exposures to the different regions of the body. The effect of total-body exposure over and beyond that of the combined regional effects was interpreted as a measure of the reaction when all cells of the body of the mouse had been exposed, or when all recovery potential had been affected.

The whole-body effect was large and suggested that all cells may contribute to recovery regardless of the organ or system involved. As a consequence, protection of any cells of the body during exposure to radiant energy may stimulate recovery.

These results indicate that the body cells retained a totipotency to assist in maintaining the organism as a whole despite the differentiation which these cells may have undergone since their stem cells left the embryologically differentiating primitive tract. They further show the importance of maintaining at least a small portion of the body free from irradiation if exposure should occur through accident or calculated risk.

Seven tables.

Delayed Effects in Mice Following Acute Total-Body X Irradiation: Modification by Experimental Treatment. Joanne Hollcroft, Egon Lorenz, Eliza Miller, Charles C. Congdon, Robert Schweisthal, and Delta Uphoff. *J. Nat. Cancer Inst.* 18: 615-640, May 1957. (J. H., Radiation Branch, National Cancer Institute, Bethesda, Md.)

Much work has been done on experimental modification of the thirty-day survival of animals receiving acute lethal total-body radiation. Comparatively few data are available on the delayed effects in animals exposed to sublethal doses of x-radiation or lethal doses of x-radiation rendered sublethal by spleen shielding or administration of protective chemicals. The present study was made to evaluate the delayed effects when irradiation was modified by spleen shielding or chemical protection or when exposure was given at birth.

An investigation of the survival of C3Hf/He mice following single doses of x-radiation showed that:

1. Control females lived longer than control males, but no sex difference in survival time was observed in the mice irradiated at birth or in those irradiated while undergoing actual or sham spleen shielding. Male mice protected with anoxia and cysteine against 900 r lived longer than females similarly treated.

2. Mice irradiated at maturity lived longer than mice irradiated at birth.

3. Long-term survival time was not influenced by spleen protection but was dependent on dose.

4. Cysteine and anoxia protection produced a dose-reduction effect reflected by a life span longer than that seen in spleen-protected mice receiving equivalent radiation.

5. A given dose of radiation was more carcinogenic to females than to males. The number of ovarian and adrenal tumors was consistently increased. Carcinogenicity was influenced by spleen protection only in that lymphosarcoma induction was decreased. Tumor types not seen in control animals were seen in irradiated mice.

6. Glomerulosclerosis was prevalent in mice receiving radiation doses that are ordinarily lethal, while pyelonephritis in the males was reduced by all irradiation treatments.

Five graphs; 12 tables.

Effect of Injection of Rat Bone Marrow on Reticular Tissues of Mice Exposed to X Radiation in the Middlethal Dose Range. C. C. Congdon, T. Makinodan, and N. Gengozian. *J. Nat. Cancer Inst.* 18: 603-613, May 1957. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

Earlier investigations showed that mice exposed to a supralethal dose of x-radiation (ca. 900 r; total-body) recovered from the radiation injury when given an intravenous injection of rat bone marrow after irradiation. On the other hand, all (C3H X 101)F₁ mice exposed to a middlethal dose (710 r; total-body) and similarly injected died in sixteen days. Thirty per cent of the mice exposed to 710 r but receiving no marrow injection died in thirty days. None of the mice injected with isologous bone marrow after 710 r died. In the present report, the authors discuss the histologic changes in the reticular tissues of mice receiving 710 r of x-radiation and rat bone marrow compared with those receiving 710 r alone or 710 r and isologous bone marrow.

The cause of death in mice irradiated with 710 r and given rat bone marrow was attributed primarily to secondary bone-marrow failure and the immunologic disease process that produced it. Deaths after thirty days in mice receiving 950 r and rat bone marrow were believed to be due to recovery of the radiation-damaged host animal's immune mechanism, resulting in a host-antibody reaction to the transplanted antigen. The experiments with the lower dose (710 r) established that a reduced injury to the host's immune response would allow its quicker recovery and a violent immune response would occur.

In the red pulp of the spleen, the destruction of blood-cell forming tissue was associated with massive proliferation of reticuloendothelial cells. To a lesser extent, these cells were also seen in the lymph nodes and bone marrow. Presumably, they represent the cellular component of the immune response to rat bone marrow. However, the relation of these cells to erythrophagocytosis and hemosiderin formation was also apparent.

Recovery of bone marrow and red pulp in the spleen of the mice treated with isologous bone marrow preceded that of the thymus, lymph nodes, and white pulp of the spleen. This sequence of events suggests that recovery of lymphatic tissues is dependent on the animal's state of health rather than directly on the injected bone marrow. In the mice receiving 710 r only, the recovery of lymphatic tissues also tended to follow bone-marrow recovery. Relative insignificant normal lymphatic

tissue recovery occurred in the irradiated mice injected with rat bone marrow. Since these animals were quite sick, failure of lymphatic tissue to regenerate might, in part, be caused by a stress reaction.

Seven photomicrographs; 5 graphs.

Some Observations on Biological Effects of Deuterium, with Special Reference to Effects on Neoplastic Processes. Joseph J. Katz, Henry L. Crespi, Robert J. Hasterlik, John F. Thomson, and Asher J. Finkel. *J. Nat. Cancer Inst.* 18: 641-659, May 1957. (J. J. K., Chemistry Division, Argonne National Laboratory, Lemont, Ill.)

The authors have verified and extended many of the observations of Barbour on the effects of deuterium on the mammalian organism (*Yale J. Biol. & Med.* 9: 551, 1937). Deuterium is easily absorbed, is toxic at elevated concentrations, and is slowly fixed in stable, non-exchangeable positions of compounds present in tissues.

Symptoms of deuterium intoxication in rats and mice include weakness, neuromuscular hyperexcitability, bradycardia, and, eventually, stupor and death; these symptoms occur at body deuteration levels of 30 to 35 atom per cent.

The blood of deuterated rats showed elevated inorganic phosphorus, nonprotein nitrogen, urea, and lactic acid and decreased glucose and plasma protein. Hypophysectomized rats exhibited the same blood changes as did unoperated, deuterated rats, but the changes occurred much earlier.

Adrenal hypertrophy in deuterated rats suggested that heavy water acted as a nonspecific stress. Liver enlargement was observed in both mice and rats that had been deuterated, but the deoxyribonucleic acid-phosphorus content of the liver indicated that this increase in liver mass was largely the result of an increase in number rather than size of cells.

Liver-function studies, including bromosulphalein and serum glutamic-oxalacetic transaminase, failed to demonstrate any consistent abnormality in deuterated mice.

Decreases in concentration of esterase, DPN-cytochrome *c* reductase, and catalase, and increases in arginine and uricase were observed in liver homogenates.

The relationship between deuteration and radiation sensitivity is exceedingly complex. In certain experiments deuterium effected a slight prolongation of the lives of irradiated mice. Interest in this aspect of the subject derives from the possibility of modifying the effect of x-irradiation by deuteration. From a consideration of fundamental principles the authors believe it is reasonable to anticipate that deuteration may alter sensitivity to other varieties of radiation as well. Numerous possibilities exist also for combining deuteration with administration of pharmacologic compounds.

Deuteration of host mice resulted in reduced growth rates of injected Krebs-2 ascites tumors and of inoculated P-1534 lymphatic leukemia.

Four graphs; 7 tables.

Regeneration and Malformation in the Nervous System, Eye, and Mesenchyme of the Mammalian Embryo After Radiation Injury. Samuel P. Hicks, Barbara L. Brown, and Constance J. D'Amato. *Am. J. Path.* 33: 459-481, May-June 1957. (Department of Pathology, New England Deaconess Hospital, Boston 15, Mass.)

Experiments have been carried out to study regeneration and malformation in the nervous system, eye, and

mesenchyme of the mammalian embryo after radiation injury. In these experiments 200 r, or occasionally 150 r, whole-body radiation were given to a pregnant rat on a certain (estimated) day of gestation. Three to four hours later some embryos were removed surgically, under ether anesthesia. Depending upon whether two, three, or four samplings were planned, one-half or a whole uterine horn was resected. This process was repeated at daily or longer intervals. Casualties involving the mother or young were rare.

Three aspects of the effect of radiation on the mammalian embryo are discussed: (1) the mechanism of radiation malformation, (2) the value of radiation as an extirpative tool for experimental mammalian embryology, (3) the problem of phenocopies (bodily changes resembling mutations but caused by environmental influences).

Although 200 r produce a highly selective necrosis of specific embryonal cells, the number and distribution of dead cells is usually far out of proportion to any malformation that might follow. The discrepancy is resolved by considering that the mammalian embryo is basically the same in its developmental processes and capacity to regenerate after injury as other vertebrates. Malformation is related to the complex balance between interference with key inductive and other growth processes and repair. It is concluded that severe cephalic defects (anencephaly) are chiefly referable to damage to the prechordal mesoderm under the neural plate in the presomite stage, and anophthalmia to interference with relations between the optic cup and ectoderm around two to six somites. Cell destruction of the selective type is severe in the neural and mesenchymal tissues, but by itself does not explain the abnormal development.

As a tool for experimental mammalian embryology, radiation shows promise as a means of investigating development of the nervous system and possibly the skeleton. If the ectoderm (epidermis) continues as resistant to higher doses as it is to 200 r, then the selective radionecrosis of the mesenchyme may provide a way to explore skeletal development. The present study and a previous one (*Arch. Path.* 57: 363, 1954. *Abst. in Radiology* 64: 633, 1955) have revealed that the early brain and spinal cord of the rat have a capacity to regulate and regenerate comparable to that described in other vertebrates.

In respect to genetic aspects, one does not expect mutations (with certain obvious exceptions) in a normal population to appear in all members of litters; and corresponding phenocopies, if they derive from mutations that need an environmental push for expression, should not appear either. The radiation malformations that regularly affect all members of a litter may be looked upon as reactions to interruption of developmental pathways normal to the species or, for that matter, in many instances normal to vertebrates. Where there are differences in response (some skeletal changes, for example) not attributable to slight differences in age of the embryos, then genetic differences in susceptibility to injury or in developmental pathways must be called to account. Whether these differences are classified as due to mutations or variations from the chromosomal configuration which is normal for the species is a matter of point of view. Further experiments, with varying doses and different strains and species, may prove to be helpful.

Fourteen photomicrographs.

Early Effects of Head X-Irradiation in Rabbits. Herbert B. Gerstner and Sidney P. Kent. *Radiation Res.* 6: 626-644, June 1957. (Department of Radiobiology, USAF School of Aviation Medicine, Randolph Field, Texas)

The effect of x-irradiation of the head on function and structure of the brain was studied in 150 rabbits. Groups of animals were examined from immediately to twenty-four hours after exposure to 9 kr, and at six hours after exposure to doses ranging from 4.2 to 9 kr. The radiation-induced changes in the central nervous system formed two complexes. The first—progressive apathy, transitory increase in brain specific gravity followed by gradual decrease, transitory increase in blood specific gravity, and focal inflammatory reactions widely distributed throughout the brain—was fully developed at six hours in the animals that had received the lowest dose (4.2 kr) and showed no appreciable increase in the animals that had received the higher doses. When the authors' findings were compared with those reported in the literature, it was suggested that the threshold dose for this group of phenomena must be sought somewhere between 2 and 3 kr. The second complex—epileptiform seizures with subsequent disturbance of posture and ataxia of movements, and pyknosis of granule cells in the cerebellum—appeared at doses in excess of about 6 kr and increased rapidly with dose. Consolidation of each of the complexes into one clinicopathologic entity was attempted.

Twelve figures.

Observations of the Local Roentgen Reaction, in Vivo, in the Sandison Clark Ear Chamber. H. A. S. van den Brenk. *Proc. Coll. Radiologists Australasia* 1: 29-39, June 1957. (Radiobiological Research Unit, Cancer Institute Board, Melbourne, Victoria, Australia)

The vascular changes which take place following local irradiation of tissues was studied with the Sandison Clark ear chamber in rabbits. The types of radiation used were x-rays from a 200-kv tube source and gamma rays from a cobalt-60 source. Only single doses were employed, ranging from 200 to 4,000 r.

Alterations in vascular tone were apparent after doses of 400 r or approximately one-third of the so-called threshold erythema dose for rabbits. On the other hand, the threshold dose level for the secondary erythema reaction in ear chambers was 2,000 r or nearly double that observed for the skin erythema threshold. Observation of the secondary irradiation reaction in the vessels of the ear chamber points to an opening of arteriovenous communications and shunts. This latter factor plays an important part in the observed redness of the radiation reaction in skin. The reddening of the tissues in a radiation reaction, then, depends not only on the dilatation of certain vessels but also on phasic alterations in caliber (vasomotion), bypassing of certain vessels through arteriovenous shunts, vascular remodeling after partial vascular destruction, and the degree of oxygenation of the blood contained in various components of the vascular plexus. However, the degree of basal dilatation observed in ear chambers is considerably less than that for skin irradiated to comparable levels and supports the view that skin erythema is largely dependent on the products of epithelial damage as opposed to a direct effect on blood vessels.

Thirty-one photomicrographs; 1 diagram; 1 table.

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Effect of X-Rays on Partially Shielded Lens of the Rabbit. Antoinette Pirie and P. Howard Flanders. *Arch. Opth.* **57**: 849-854, June 1957. (Nuffield Laboratory of Ophthalmology, Oxford, England)

Two experiments were carried out to determine the effects of x-rays on the partially shielded lens of the rabbit: (1) irradiation of the axial core or of a small area of the periphery; (2) irradiation of the total periphery with center shielded or irradiation of about three-fourths of the periphery and center.

No opacity at all was produced when the axial core of the lens was irradiated with 1,600 rad, but in a large number of rabbits of the same breed and age as those used in the present experiment, 1,400 rad given to the whole eye has been found to cause complete cataract in five to ten months. A dose of 1,600 rad to an area of periphery produced cortical opacities within that area. In only 1 lens was there a possible significant difference in weight after peripheral irradiation. Total glutathione showed a slight decrease in 2 lenses and a similar increase in a third.

Irradiation of the lens with a 5-mm. lead stop placed centrally, so that the whole periphery of the lens was irradiated, resulted in a complete cataract in 3 out of 5 rabbits, whereas irradiation with the stop placed eccentrically, so that a sector of peripheral epithelium escaped, produced no complete cataracts in 5 rabbits. The complete cataracts developed within three months of the time of radiation and when the rabbits were killed, one and a half to two months later, the lenses were intumescent and weighed considerably more than the normal fellow lenses. The other irradiated lenses were all lighter than their normal fellows, which the authors interpret as representing a slowing of growth after irradiation.

The authors conclude that the lens fibers are dependent on the peripheral tissue (? germinal epithelium) of the lens and that if a small fraction of this remains healthy the fibers will remain normal. This seems to show that fibers lying under damaged peripheral epithelium must be able to get nourishment from contiguous healthy fibers and epithelium. Radiation cataracts in which total opacity of the lens develops may therefore be considered to have two stages. Radiation damages only the peripheral epithelial cells and perhaps the most newly formed fibers. Secondary to and consequent upon this radiation damage is a loss of transparency of the fibers of the lens. The latter supervenes only if sufficient periphery has been damaged.

Two figures; 3 tables.

The Effect of Cell Suspensions upon the Development of Cataracts in Irradiated Mice. Frank W. Newell, Thomas C. Beaman, Leon O. Jacobson, Edna K. Marks, and Evelyn O. Caston. *Arch. Opth.* **57**: 846-848, June 1957. (Argonne Cancer Research Hospital, 950 E. 59th St., Chicago 37, Ill.)

The authors conducted an investigation to learn whether the injection of cellular substances after irradiation might modify the development of cataracts. Mice were subjected to total-body irradiation ranging between 750 and 975 r. Within four hours, various cell suspensions (embryo cells, spleen cells, etc.) which have been found to be effective in prolonging life of lethally irradiated mice were injected. A study of the lenses of all mice receiving cell suspensions failed to indicate any deterring action against the development of cataract.

Glutathione Protection in X-Irradiated Eyes. A Preliminary Report on Enzymatic and Clinical Changes. Arnold A. Swanson, Heinrich W. Rose, and Jack I. Taube. *Arch. Opth.* **57**: 832-839, June 1957. (School of Aviation Medicine, U.S.A.F., Randolph Air Force Base, Texas)

A preliminary investigation has been made by the authors of the clinical and enzymatic changes in rabbit eyes after x-irradiation alone and after x-irradiation preceded by injection of glutathione.

Conjunctiva, cornea, anterior chamber, iris, and ciliary body, as well as retina, showed marked changes due to irradiation. The difference between the treated and untreated animals was sufficient to indicate that administration of glutathione is definitely protective for 800 r and at least moderately protective against the described clinical changes at higher levels of irradiation.

Irradiation with 2,240 and 6,000 r produced significant decreases in succinic dehydrogenase, cytochrome oxidase, and glucose-6-phosphate dehydrogenase activity for all tissues, as compared with controls. Only the glucose-6-PO₄ dehydrogenase activity of iris and ciliary body appeared not to recover forty-eight hours after irradiation when glutathione was administered.

Protection against ionizing radiation with glutathione was significant in the retina, lens capsule, and iris for succinic dehydrogenase and cytochrome oxidase activity.

Eight photographs in color; 1 chart; 4 tables.

Effects of Prolonged Administration of Cortisone and Antibiotics (Penicillin and Streptomycin) on X-Irradiated Lung Tissue of Rats. Hans Cottier. *Strahlentherapie* **103**: 77-90, May 1957. (In German) (Röntgeninstitut der Universität, Bern, Switzerland)

Cortisone with and without penicillin was administered daily to rats for a period of four months following irradiation of a pulmonary field, 1.5 × 2 cm., with a single exposure of 3,000 r.

Small doses of cortisone (2 mg. per kilogram of body weight per day) had no significant effect on x-ray induced pulmonary changes. Larger doses (10 and 20 mg. per kilogram per day) decreased the incidence of irradiation fibrosis but produced unfavorable results, such as increased mortality, acute pneumonia, atypical epithelial proliferations with purulent bronchitis, and pulmonary necrosis.

Roentgenologically detected pulmonary densities always persisted, except in 2 animals, in which they disappeared while under antibiotic treatment. Postirradiation pulmonary mycosis developed in 2 animals treated with cortisone and antibiotics.

On the basis of these experimental observations, the author concludes that prolonged cortisone therapy following pulmonary irradiation is not to be recommended.

Five roentgenograms; 4 photomicrographs; 1 chart.

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Spatial Avoidance in the Rat as a Result of Exposure to Ionizing Radiation. John Garcia, D. J. Kineldorf, and E. L. Hunt. *Brit. J. Radiol.* **30**: 318-321, June 1957. (Division of Biology and Medicine, U. S. Naval Radiological Defence Laboratory, San Francisco 24, Calif.)

In order to determine if animals can learn to avoid an area in which they have previously been exposed to

ionizing radiation, rats were irradiated while confined to one of two distinctive compartments of an enclosed alley. (Radiation doses were 0 r, 50 r, 85 r, and 120 r per exposure for the various groups.) Immediately following exposure the rats were returned to their home cage. On the next day each animal was confined to the opposite compartment for a similar period in the absence of radiation. Following four cycles of radiation exposure alternated with sham irradiation, the partition between the two compartments was removed and the animals were given a free choice of residence in the alley for a test period. With but one exception in 40, the irradiated animals demonstrated an avoidance reaction toward the compartment in which they had been exposed to radiation. It was concluded that both x and gamma radiation can serve as unconditioned stimuli in the establishment of spatial avoidance behavior.

One table.

Authors' Abstract

A Hand Tintometer for Radiological and Dermatological Work. B. Jolles and R. G. Mitchell. *Lancet* 1: 1333, June 29, 1957. (General Hospital, Northampton, England)

In radiological work it is often desirable to measure

and record radiation reactions of the skin. The authors describe an instrument which has been developed for this purpose. In viewing with this "tintometer," a circular split field is seen, one segment being the sample under examination and the other a standard white surface, both being illuminated equally with three electric bulbs inside the instrument. By means of rotatable disks a graded series of "Lovibond Glass Standards," colored red, yellow, and blue, can be interposed between the source of illumination and the white surface, the combination being adjusted until the two segments are matched in tone and intensity. The values of the sample are defined in terms of the amount of each of the three filters required for color match. Provision is also made for insertion of neutral tints over the sample, if this is excessively bright. Practice is required to use the instrument to the best advantage, and it is advisable always to use it under the same conditions of room lighting. As color is a subjective sensation, the same person should make all the measurements in one series of experiments.

The instrument has been found useful in radiobiological and dermatological work, as a research tool, and for color matching in plastic surgery.



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